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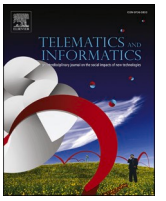

Why do metaverse government services fail? Understanding the influences of different failure types on citizens' satisfaction with meta-government services in China

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ABSTRACT

The metaverse is still in its early stages, and most prototype metaverse platforms fail to fulfill their potential and meet users' demands. Numerous studies have focused on the success of metaverse applications. However, there has been limited research on the failure of the metaverse services. Based on digital service failure model (DSFM), uses and gratification theory (U&G), and organizational failure diagnosis model (OFDM), an integrated model to investigate the influences of different failure types on citizens' satisfaction with *meta*-government services is developed. The model was tested using a survey of 402 responses in China, which were analyzed using a hybrid structural equation modeling artificial neural network (SEM-ANN) approach. The findings indicated that organizational failure exerts the most powerful effect on citizens' satisfaction. Moreover, information, service, system, and psychological needs failure, negatively influence citizens' satisfaction. In addition, technology anxiety can weaken the influences of information, system, psychological needs, and organizational failures on citizens' satisfaction while enhancing the relationship between service failure and citizens' satisfaction. This research contributes initial and original insights into the failure types of *meta*-government services and their impacts, addressing a significant gap in the literature.

1. Introduction

Citizens' service quality expectations are higher than ever, and governments are expected to continually search for new ideas and opportunities that will lead to innovations in providing greater, faster, and more effective digital public services (Bertot et al., 2016; Choi et al., 2022). The metaverse is considered one of the most recent technologies for enhancing the delivery of government services (Lnenicka et al., 2024). The metaverse depends on the convergence of artificial intelligence (AI), augmented realities (AR), virtual realities (VR), blockchain, cloud computing, and other cutting-edge technologies (Al-Adwan, 2024). It creates an immersive 3D virtual space in which users interact through avatars (Wang et al., 2023).

Theoretically, the metaverse has great potential for strengthening government services. Currently, e-government services are provided through 2D surfaces, such as mobiles and computers. The metaverse creates a virtual world that allows users to receive governmental services and interact with others in a more intuitive and immersive way. Virtual and online environments can enable

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effective, accountable, human-centric, and trustworthy service provision while reducing expenditure, time, and bureaucracy (Allam et al., 2022).

Specifically, for local governments, the metaverse might emerge as a significant channel for positive civic participation, real-time service delivery, and the optimized management of public spaces (Kshetri et al., 2024). Moreover, the metaverse has also played a key role in governmental service delivery during the COVID-19 pandemic (Ruchkin et al., 2021). Given the potential of the metaverse, various countries, including China, South Korea, Saudi Arabia, and Japan, have announced their interest in providing public services in the metaverse (Thompson, 2022; Kshetri et al., 2024). Integrating government and the metaverse paves the way for a metaverse government (*meta*-government). Recently, a growing number of proto-metaverse platforms that offer government services have been developed. For instance, "Seoul's Metaverse City" initiative plans to permit citizens to access a great number of government services through avatars, such as social insurance payment, passport application, and certificate authentication (Lnenicka et al., 2024).

However, transforming from a physical to a virtual world poses serious challenges that the government must address (Yfantis & Ntalianis, 2022). One major obstacle is that the metaverse hardware, software, and infrastructure require significant investments. For example, VR and AR headsets are immature and are in short supply. Governments may struggle to justify these costs (Wan et al., 2023). Moreover, illegal content and dangerous activities within metaverse spaces have become challenging (Al-Adwan, 2024). Currently, the "true" metaverse is still a vision. In the area of public administration, *meta*-government platforms are in their early stages. For example, government in Finland decides to implement "the city of Tampere" to develop a metaverse city that includes mobility, healthcare, security, and events. However, the program is still in the research phase (Wray, 2023). In Japan, government agencies are exploring a metaverse-based education support system to help children who refuse to go to school (Kshetri et al., 2024). According to Chen et al. (2024), currently, most of *meta*-government platforms are problematic and cannot offer complete government services. However, these proto-metaverse platforms provide great opportunities to explore one of the most significant factors in government service delivery: service failure.

Research on the service delivery of metaverse applications has emerged in fields such as tourism (Tsai, 2020), banking (Nguyen et al., 2023), education (Capatina et al., 2024), and gaming (Shin, 2022). Studies investigating citizens' attitudes and behavioral outcomes when using governmental services in the metaverse are lacking. More importantly, numerous studies have focused on the success of metaverse applications (Ahn et al., 2024; Capatina et al., 2024; Mirza et al., 2024); however, the failure of metaverse has not been explored yet. The impact of service failure on citizen satisfaction is not known.

Currently, services are often unsuccessful because the user experience is often poor. Proto-metaverse government platforms have many issues, such as incomplete service, inaccurate information, delays, and lack of interaction (Al-Adwan, 2024). Consequently, citizens tend to feel dissatisfied with the public services in the metaverse. However, owing to these unsuccessful *meta*-government platforms, we can develop valuable insights into the relationship between different failure types and user satisfaction with *meta*-governments. Thus, this study posed the following research aim: What is the influence of different failure types on citizens' satisfaction with public services in the metaverse?

By addressing this research objective, this study is the first to explore the service failures of *meta*-governments. It fills this research gap by offering theoretical and practical insights into the relationship between service failure types and citizen satisfaction with *meta*-governments. These findings will help inform strategies to strengthen *meta*-government services and avoid service failures.

This study employs a hybrid structural equation modeling artificial neural network (SEM-ANN) approach. It constructs a research model based on the digital service failure model (DSFM), use and gratification theory (U&G), and organizational failure diagnosis model (OFDM). In the digital service context, the influence of service failure on user satisfaction is a complex process that cannot be fully understood using linear models (Tan et al., 2016; Leong et al., 2020; Xiong et al., 2022). Therefore, this study captures non-compensatory and non-linear relationships by utilizing a linear-nonlinear SEM-ANN model to conduct hypothesis testing. First, SEM was used to test the influence of different failure types on citizens' satisfaction with *meta*-government. Totally, 10 research hypotheses were developed: information (H1), service (H2), system (H3), psychological needs (H4), and organizational failures (H5) were assumed to have significant influences on citizens' satisfaction, and technology anxiety was assumed to greatly moderate the impacts of failures on citizens' satisfaction (H6a-H6e). ANN was then employed to rank the relative influence of the significant failure types obtained from the SEM. Finally, a hierarchical multiple regression analysis was performed to test the moderating role of technology anxiety. The soundness and robustness of the overall research findings were reinforced through the SEM-ANN approach.

2. Literature review

2.1. Service failure of meta-government

Service failure occurs when a service does not meet customer expectations (Kim & So, 2023; Zhu et al., 2024a). According to Smith et al. (1999), service failure refers to a service failing to meet people's demands, which makes them feel dissatisfied. Lewis and Spyrakopoulos (2001) believe that service failure occurs when customers are dissatisfied with services. In this sense, if *meta*-government services cannot meet or exceed the expectations of a citizen, the person perceives the *meta*-government as failing. Thus, in this study, the service failure of *meta*-government refers to its failure to meet citizens' demands, causing them to be dissatisfied. Thus, citizen satisfaction was considered a dependent variable in this study to represent the outcome of service failure of public services in the metaverse.

2.2. Digital service failure model

DSFM was introduced by Mustafa et al. (2020). This model combines the information system (IS) failure model proposed by Tan et al. (2016) and the IS success model proposed by Delone and McLean (2003). Delone and McLean (1992) developed the initial IS success model by considering use, user satisfaction, information quality, system quality, and individual and organizational impacts as dependent variables. Ten years later, service quality was added to the IS success model as the dependent variable (Delone and McLean, 2003). The IS success model has been used to investigate the success of IS services in a wide range of fields, including e-government (Jung, 2019), online shopping (Ma, 2021), and e-learning (Jahan et al., 2024). However, the IS success model neglects the failure categories of IS services (Mustafa et al., 2020). Tan et al. (2016) converted the IS success model into the IS failure model and developed a novel classification system that delineates IS service failures into functional, information, and system dimensions to fill this gap.

Based on the IS success and IS failure models, DSFM extends the theoretical and practical perspectives to address the failures people face. This theoretical model identifies four types of IS service failures: three types of failure (functional failure, information failure, and system failure) adapted from the IS failure model (2016) and one type of failure (service failure) adapted from the IS success model (2003).

2.3. Uses and gratification theory

U&G was first introduced in the 1940 s and since has been extensively utilized to identify the psychological needs of individuals that stimulate their use of IS products or services (Lee & Ma, 2012; Li et al., 2015; Introne et al., 2018; Thompson et al., 2019). The U&G theory proposes that individuals are active users who selectively use IS products or services that fulfill their psychological demands (Joo & Sang, 2013). It suggests that people decide to gratify four types of psychological needs when using IS products or services: cognitive, affective, personal integrative, and social integrative needs (Keelson et al., 2024). Cognitive needs refer to demands for knowledge and learning (Apuke & Omar, 2021). Introne et al. (2018) used information learning as a variable to describe cognitive needs. Affective needs refer to demands for emotional arousal, such as entertainment (Apuke & Omar, 2021) and enjoyment (Li et al., 2015). Personal integrative needs refer to the demands for strengthening one's identity, such as self-presentation (Li et al., 2015) and esthetic experiences (Baek et al., 2011). Social integrative needs refer to demands for social interactions such as socialization (Lee & Ma, 2012) and relationship maintenance (Dunne et al., 2010).

Citizens set expectations before using *meta*-government; these expectations also include psychological demands. If *meta*-government services cannot meet citizens' cognitive, affective, personal integrative, and social integrative demands, the risk of service failure increases.

2.4. Organizational failure diagnosis model

Organization is another aspect that may cause service failure in the IS field (Choi & Mattila, 2008; Gohary et al., 2016). Organizations shoulder the responsibility for IS development, meaning they need to ensure they can manage IS and provide services (Doherty & King, 1998). If the capability of an organization cannot meet the requirements of service delivery, the risk of service failure increases. OFDM outlines several organizational elements that might lead to IS service failure. The first is organizational efficacy, which refers to the organizational capacity for IS development, including management style and level of organizational maturity (Goulielmos, 2005). The second is appropriate approaches, which refers to the methodological actions taken by organizations to promote IS development (Goulielmos, 2003). The third is systems change, which refers to the capacity to keep the IS updated (Goulielmos, 2005). These three elements will be used in this research to identify the service failure in organizational dimension.

2.5. Types of meta-government services failure

Based on DSFM, U&G, and OFDM, this study identified five failure types of *meta*-government services: information, service, system failures from DSFM, psychological needs failure from U&G, and organizational failures from OFDM. The five types explain the failure of *meta*-government in different dimensions. According to DSFM, a functional failure is used to describe service failures in e-commerce. This includes acquisition and post-purchase failures (Mustafa et al., 2020). Thus, functional failure was excluded from this study because it is not suitable for *meta*-government.

2.5.1. Information failure

Information failure occurs whenever the information provided on a *meta*-government platform hinders citizens from accomplishing their transactional goals (Tan et al., 2016). According to DSFM, information failure includes inaccurate, incomplete, irrelevant, and untimely information (Mustafa et al., 2020).

2.5.2. Service failure

Service failure occurs whenever services provided on *meta*-government platforms are incapable of supporting citizens in accomplishing their transactional objectives (Tan et al., 2016). According to DSFM, service failure is caused by unresponsiveness, unreliability, intangibility, and lack of empathy (Mustafa et al., 2020).

2.5.3. System failure

System failure occurs when the service content provided by a *meta*-government platform is not delivered in a manner that facilitates citizens to accomplish their transactional goals (Tan et al., 2016). According to DSFM, the system failure of digital services is caused by inaccessibility, non-navigability, delay, and insecurity (Mustafa et al., 2020).

2.5.4. Psychological needs failure

Psychological needs failure occurs when the *meta*-government is unable to meet citizens' psychological goals. According to U&G, cognitive, affective, personal integrative, and social integrative needs are significant psychological objectives when using IS services (Keelson et al., 2024). Thus, it can be said that psychological needs failure is caused by lack of information learning, boredom, non-esthetic, and lack of social interaction.

2.5.5. Organizational failure

Organizational failure occurs when governments cannot manage and develop *meta*-governments to meet citizens' service needs. In the case of the *meta*-government, governments become the main organizations that provide services. Thus, this study employed the lack of administrative departments to represent a shortage in organizational efficacy. Furthermore, the inadequacy of legislation was used to demonstrate that governments have not taken an appropriate approach to managing *meta*-governments. In addition, unsustainable investment was used to represent obstacles to supporting system updates.

3. Hypothesis development

Information is essential to service quality and satisfaction (Oliver, 1980). Inaccurate, incomplete, irrelevant, and untimely information cannot match individuals' requirements and, in turn, can decrease their satisfaction (Kim et al., 2021). As a typical type of digital service failure, information failure occurs due to incorrect, insufficient, irrelevant, and untimely data (Mustafa et al., 2020). In the context of *meta*-government, citizens' expectations of information quality cannot be satisfied when a *meta*-government platform fails to provide accurate, complete, relevant, and up-to-date information. In such cases, information failure might decrease citizens' satisfaction with *meta*-government. Thus, the following hypothesis is formulated:

H1. *Information failure has a negative impact on citizens' satisfaction with meta-government services*.

The metaverse service required by citizens should be responsive, reliable, tangible, and warm (Ahn et al., 2024; Hajian et al., 2024; Capatina et al., 2024). According to previous studies on e-services, non-responsive service reflects inefficiency in reporting and thus causes a reduction of satisfaction (Capatina et al., 2024), unreliable smart transport service significantly decreased user satisfaction (Eneko et al., 2020), and individuals felt dissatisfied when tourism chatbots lack the empathic ability (Orden-Mejía & Huertas, 2022). Before using *meta*-government services, citizens set their expectations on service quality. However, the transaction process will be worse than expected if the *meta*-government service is non-responsive, unreliable, intangible, and lacks empathy. Consequently, citizens' satisfaction might become lower. Based on the arguments above, we hypothesize that:

H2. *Service failure has a negative impact on citizens' satisfaction with meta-government service*.

When citizens visit a *meta*-government platform, they begin to experience the system. Inaccessibility, lack of navigation, and delay of the system increase the time spent on *meta*-government. Prior studies showed that time-wasting during accessing, searching, and selecting lowers user satisfaction, and eventually, people refuse to continue the transaction (Mustafa et al., 2020; Zhu et al., 2023). Moreover, individuals worry about their private information. If *meta*-government fails to offer enough security, citizens will be more likely to feel anxious and dissatisfied. Therefore, we hypothesize that:

H3. *System failure has a negative impact on citizens' satisfaction with meta-government service*.

Digital services will become successful if these services meet individuals' psychological demands (Li et al., 2015). Learning is a basic psychological need when using new services because people desire to satisfy their curiosity (Teng, 2018; Chen et al., 2021). Previous studies proved that learning positively impacts user satisfaction with mental health chatbots (Zhu et al., 2022). In addition, a VR tourism without entertainment and esthetic experiences fails to increase user satisfaction (Leung et al., 2013). Furthermore, people also need to develop social relationships by using various digital services (Huang & Hsieh, 2011; Zhu et al., 2024b). Meta-government provides a virtual place for government service delivery. Before using *meta*-government, citizens set expectations on psychological demands, including learning, entertainment, esthetic, and social interaction. If *meta*-government fails to meet their needs, user satisfaction will likely decrease. Thus, the following hypothesis is formulated:

H4. *Psychological needs failure has a negative impact on citizens' satisfaction with meta-government service*.

In the case of *meta*-government service, the government is responsible for showing organizational efficacy, using appropriate approaches, and making sustainable investments. Generally, people tend to highlight the role of government in public service delivery (Gesk & Leyer, 2022; Wouters et al., 2023). Thus, citizens expect that the government can professionally administrate the delivery of *meta*-government services. In addition, they also expect that government can promote legislation and make continuous investments to develop *meta*-government. If the government performs worse than citizens' expectations, citizens will think the government is incapable and irresponsible. As a result, they might feel dissatisfied with the *meta*-government service. Therefore, we hypothesize that:

H5. *Organizational failure has a negative impact on citizens' satisfaction with meta-government service*.

Technology anxiety entails the degree to which a person has difficulty or fear receiving and using technologies (Wilson et al., 2023). Prior literature has indicated that technology anxiety is conceptualized as a moderator that influences individuals' behavioral outcomes when using AI-based chatbots (Li et al., 2021) and e-payment (Zhang & Zhang, 2024). Despite the significance of technology anxiety, its moderating role has not yet been understood in the context of *meta*-government service failure.

People with technology anxiety usually feel pressure when using cutting-edge technologies (Yang & Forney,2013), such as *meta*-government. Citizens with a high level of technology anxiety towards *meta*-government might not have a high initial expectation of information quality. When they find that *meta*-government offers inaccurate, incomplete, or irrelevant information, they tend to feel normal due to their lower perception of *meta*-government.

However, when information service quality is high, their post-use confirmation tends to become stronger than those with less technology anxiety. Previous studies have demonstrated that the accuracy of information services has a stronger impact on people with technology anxiety (Li et al., 2021). Similarly, citizens with high technology anxiety might be less influenced by service failure of *meta*-government. According to Meuter et al. (2003), people who have high technology anxiety avoid using computer-based services but seek human agents. Thus, citizens with technology anxiety might not set high expectations on intangible *meta*-government. However, if the intangible services provided by *meta*-government are responsive, reliable, and warm, citizens with higher levels of technology anxiety will feel a stronger post-use confirmation.

System failure might also show a weaker impact on those who have a high level of technology anxiety. Before using *meta*-government, citizens with technology anxiety set a lower expectation of system quality because they believe the system of *meta*-government is inaccessible, unsafe, and full of bugs. Thus, when a system failure occurs, they tend to feel not surprised, and their satisfaction level is more likely to be sustained.

Furthermore, technology anxiety might weaken the relationship between psychological needs failure and satisfaction. Because individuals who have a high level of technology anxiety do not believe that *meta*-government can satisfy their cognitive, affective,

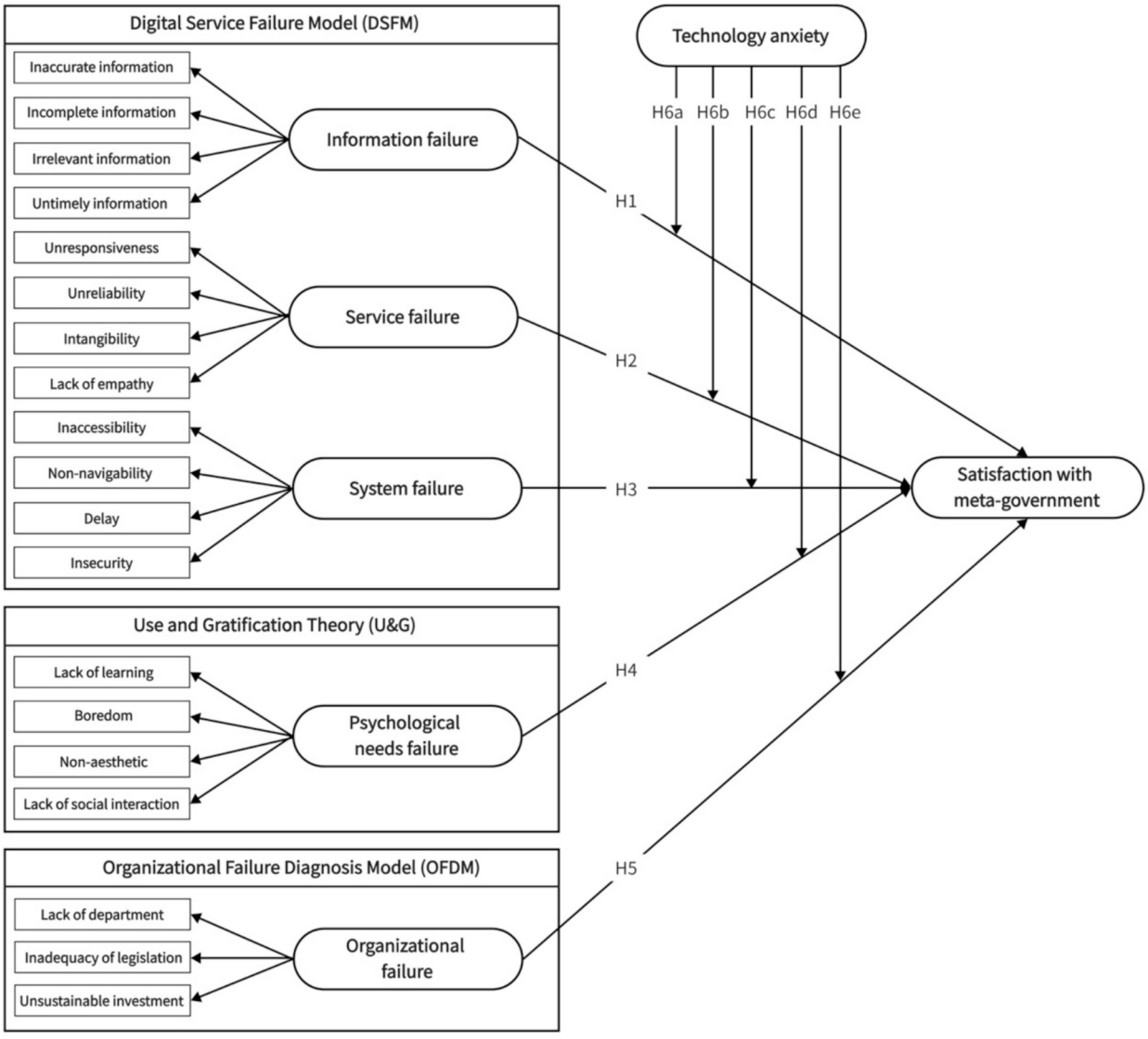

Fig. 1. Research model and research hypotheses.

personal integrative, and social integrative needs, when service delivery really fails to meet citizens' psychological demands, their satisfaction might not be significantly reduced. In addition, because people with technology anxiety tend to perceive technologies as unpredictable, uncontrollable, and risky (Lee & Yang, 2013), they do not believe that governments have the capability to manage *meta*-government. When they find that there is a lack of administration, legislation, and investment, they might not have a strong feeling of dissatisfaction. Based on the arguments above, we hypothesize that:

H6a. *Technology anxiety weakens the influence of information failure on citizens' satisfaction with meta-government service.*

H6b. *Technology anxiety weakens the influence of service failure on citizens' satisfaction with meta-government service.*

H6c. *Technology anxiety weakens the influence of system failure on citizens' satisfaction with meta-government service.*

H6d. *Technology anxiety weakens the influence of psychological needs failure on citizens' satisfaction with meta-government service.*

H6e. *Technology anxiety weakens the influence of organizational failure on citizens' satisfaction with meta-government service.*

The research model and research hypotheses are depicted in Fig. 1.

4. Research approach.

4.1 Research process.

This research employed SEM-ANN approach and three hierarchical regressions analysis. Specifically, a two-stage SEM-ANN approach was used to investigate the relationship between service failure and citizens' satisfaction with *meta*-government. We selected SEM-ANN analysis for the following reasons:

First, as suggested by the previous studies (Chong, 2013; Tan et al., 2014), human behavioral outcomes might not always follow a linear relationship. Thus, SEM may oversimplify complex human behavioral outcomes because it can only test linear relationships. Second, ANN can test non-linear relationships through a non-compensatory model (Leong et al., 2020), which can resolve the complexity of human behavioral outcomes. Third, although ANN can examine non-linear relationships, this approach is more suitable for prediction but is unable to test research hypotheses due to the "black-box" operation mechanism (Xiong et al., 2022). Finally, we

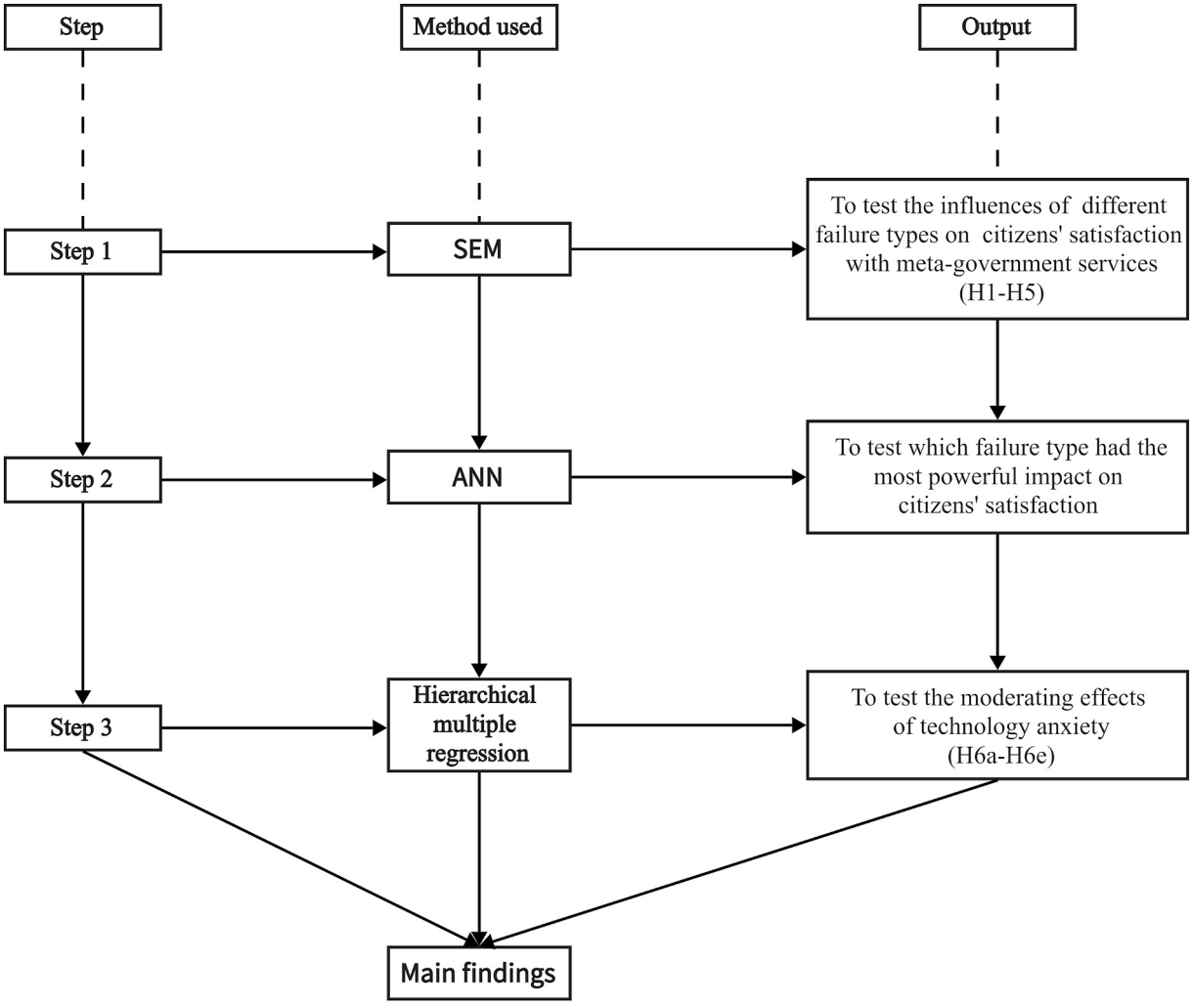

Fig. 2. Research process.

employed a two-stage SEM-ANN analysis to exploit their advantages and overcome their disadvantages.

In the first stage, SEM was used to test H1-H5 and identify the significant variables. In the second stage, the statistically significant independent variables obtained from SEM were employed as the input neurons for ANN analysis. Then, the sensitive analysis of ANN was conducted to rank the significance of the input nodes.

Finally, three hierarchical regressions analysis was conducted to test the moderating roles of technology anxiety (H6a-H6e). Fig. 2 shows the research process of this study.

3.1. Data collection

Following the prior studies on the metaverse services (Al-Adwan, 2024; Ahn et al., 2024; Kumar et al., 2024), this research also employed a quantitative, cross-sectional survey to collect research data. In order to provide more efficient services for citizens, government in China has made great efforts to improve the facilities and environments of e-service delivery over the last decade (Zhang & Zhu, 2021). Shandong government in China is one of the earliest local governments that constructs proto-metaverse platform of governmental services (Chen et al., 2024). From December 2023 to January 2024, we cooperated with the local public affairs Service Centers and the Bureau of Big data Development and Management in Shandong. The link between the proto-metaverse platform and the online questionnaire was distributed to citizens with prior experience using VR technologies. Their experience with the VR environment allows them to evaluate the service delivery of *meta*-government better. Before the formal collection, 20 users, two professors, and two practitioners were invited to conduct the pilot test. According to their feedback, revisions were made to ensure the survey's appropriateness, relevance, and representativeness.

The final questionnaire began with a brief overview of the objective of the research. Then, a screening question was tested to ensure all participants had prior experience with VR services. The next part gathered respondents' prior VR experience and demographic information, such as age, gender, income, and education. The last section measured individuals' opinions on the research model's constructs. 425 respondents with prior VR experience were received. After discarding incomplete surveys, deleting surveys that were completed within 5 % < of the allocated time (Zhu et al., 2024b), and excluding respondents under 18, 403 valid responses were collected for the analysis in this research.

Table 1 presents the demographic information. Among the respondents, 239 were males (59.5 %) and 163 were females (40.5 %). Regarding to age, 182 respondents (45.3 %) were between 18 and 25, 174 respondents (43.3 %) were between 25 and 30, and only 46 respondents (11.4 %) were over 30. In terms of education, 324 respondents (80.7 %) held an undergraduate degree, while 78 respondents (19.3 %) did not. Regarding to annual income, 178 respondents (44.3 %) were between CNY 30,001 and 100,000, 130 respondents (32.3 %) were between CNY 100,001 and 500,000, and only 14 respondents (3.5 %) were over CNY 500,000. In addition, 125 respondents (31.1 %) had more than 1 year of VR experience, while 227 respondents' (68.9 %) experiences were less than 1 year.

3.2. Measurement scales

In this research, all the survey items measuring the constructs were adapted from the existing studies on DSFM, U&G, OFDM, and VR/AR/ metaverse services. Specifically, according to Tan et al. (2016), four items were modified to measure information failure. Measurement items for service failure and system failure were adapted from Mustafa et al. (2020). Items measuring psychological needs failure were adapted from Introne et al. (2018) and Thompson et al. (2019). The items developed by Goulielmos (2005) were utilized to measure organizational failure. Technology anxiety was measured with three items adapted from Li et al. (2021), while the construct of satisfaction was modified according to Zhu et al. (2022).

Table 1
Demographic information of the respondents.

		Number	Percentage (%)
Gender	Male	239	59.5
	Female	163	40.5
Age	18–25	182	45.3
	25–30	174	43.3
	30–40	40	9.9
	Above 40	6	1.5
Education	Below high school	7	1.7
	High school	19	4.7
	Polytechnic college	52	12.9
	Bachelor's degree	281	70.0
	Master's degree or above	43	10.7
Income	CNY 30,000 or below	80	19.9
	CNY 30,001–100,000	178	44.3
	CNY100,001–300,000	99	24.6
	CNY 300,001–500,000	31	7.7
	Above CNY 500,000	14	3.5
VR experience	Less than 1 year	277	68.9
	1–2 years	77	19.2
	Above 2 years	48	11.9

The measurement items were translated into Chinese language according to the back-translation approach (Brislin, 1970). All items used a five-point Likert scale ranging from "highly disagree" to "highly agree". The research model comprised 7 variables with a total of 26 indicators, as shown by Appendix A.

3.3. Control variables

Demographic information, such as age, gender, educational level, income, and prior VR experience were considered as control variables in this research because demographic factors might affect empirical results, as suggested by the previous studies (Cheng & Mitomo, 2017; Ashfaq et al., 2020; Zhu et al., 2024b).

4. Results

4.1. SEM results

4.1.1. Common method bias (CMB)

To check common method bias (CMB), a principal component analysis method with "Harman's one-factor test" was employed. According to previous studies, CMB occurs when the value of a single construct is above 40 % of the variance (Podsakoff et al., 2003; Xiong et al., 2022; Zhu et al., 2024b). In this research, the findings showed that the variance of a single construct is 15.21, indicating that the dataset is without CMB.

4.1.2. Measurement model assessment

To test the reliability and validity in this research, confirmatory factor analysis was conducted. As presented in Table 2, Cronbach α and Composite reliability (CR) values were above 0.7, demonstrating that the internal consistency reliability is adequate (Hair et al., 2019). In addition, the Average Variance Extracted (AVE) exceeds the limit value of 0.5, suggesting adequate convergent validity (Seo & Bernsen, 2016). Furthermore, the factor loading of all items was over the recommended value of 0.6, indicating that all measurement items have appropriate reliability (Zhu et al., 2022).

Fornell and Larcker criterion was used to examine discriminant validity in this research. As suggested by Fornell and Larcker (1981), we compared every construct's inter-construct and the $\sqrt{\text{AVE}}$. As shown in Table 3, the $\sqrt{\text{AVE}}$ of all constructs surpassed the correlations among constructs, thus establishing the discriminant validity (Leong et al., 2020).

Moreover, according to Table 4, x^2/df was 1.678 ($\leq$3.00), CFI and GFI were 0.961 and 0.917, respectively ($\geq$0.90), RMR (0.037) and SRMR (0.041) were less than 0.05, RMSEA was 0.041 ($<$0.05), and NFI was 0.910 ($\geq$0.90). Thus, the measurement model returned a good model fit (Kaur et al., 2018; Zhu et al., 2023).

Table 2
Construct reliability and validity.

Construct	Item	Mean	Factor loading	α	CR	AVE
Information failure (IF)	IF1	4.60	0.792	0.782	0.815	0.526
	IF2	4.39	0.699			
	IF3	4.52	0.759			
	IF4	4.42	0.641			
Service failure (SF)	SF1	4.02	0.611	0.860	0.862	0.614
	SF2	3.21	0.865			
	SF3	2.99	0.786			
	SF4	3.21	0.857			
System failure (SYF)	SYF1	4.32	0.891	0.846	0.851	0.590
	SYF2	4.15	0.717			
	SYF3	4.13	0.688			
	SYF4	4.28	0.761			
Psychological needs failure (PNF)	PNF1	4.16	0.653	0.844	0.846	0.582
	PNF2	4.06	0.876			
	PNF3	4.16	0.683			
	PNF4	4.03	0.818			
Organizational failure (OF)	OF1	4.66	0.877	0.920	0.908	0.767
	OF2	4.63	0.889			
	OF3	4.61	0.861			
Technology anxiety (TA)	TA1	3.73	0.880	0.906	0.913	0.777
	TA2	3.75	0.884			
	TA3	3.81	0.881			
Citizens' satisfaction (CS)	CS1	1.99	0.692	0.818	0.820	0.533
	CS2	2.19	0.812			
	CS3	2.12	0.696			
	CS4	2.11	0.714			

Table 3
Fornell and Larcker test.

	IF	SF	SYF	PNF	OF	TA	CS
IF	0.725						
SF	0.098	0.784					
SYF	0.032	0.036	0.743				
PNF	0.036	0.045	0.095	0.726			
OF	0.200	−0.018	0.040	−0.007	0.876		
TA	−0.015	−0.002	0.069	−0.045	−0.039	0.881	
CS	−0.173	−0.129	−0.174	−0.173	−0.212	−0.045	0.730

Table 4
Goodness-of-fit.

Goodness-of-fit measures	CMIN/df	CFI	GFI	RMSEA	RMR	SRMR	NFI
Recommended value	≤3.00	≥0.90	≥0.90	<0.05	<0.05	<0.05	≥0.90
This model	1.678	0.961	0.917	0.041	0.037	0.041	0.910

4.1.3. Structural model assessment

After proving adequate measurement properties, the research hypotheses were tested. Bootstrapping with 5000 resamples was applied to generate the significance of path coefficients and p-values (Ahn et al., 2024). The findings of path analysis are presented in Fig. 3. Specifically, information failure negatively impacted citizens' satisfaction with *meta*-government services (β = -0.115, $p < 0.05$), offering support to H1. Furthermore, service failure (β = -0.134, $p < 0.05$) and system failure (β = -0.159, $p < 0.01$) also had

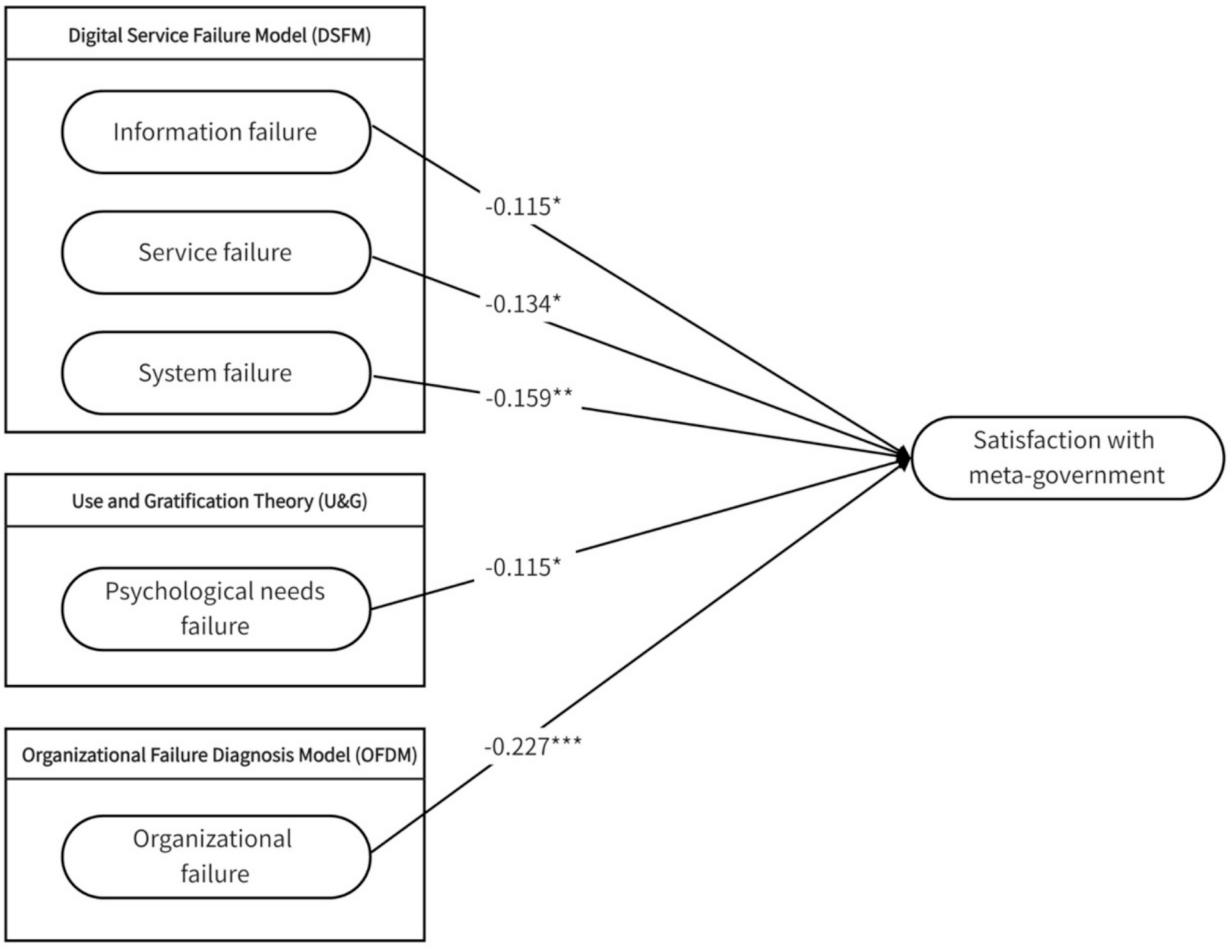

Fig. 3. The results of path analysis. *p < 0.05, **p < 0.01, ***p < 0.001.

negative influences on citizens' satisfaction. Thus, H2 and H3 should be supported. In addition, psychological needs failure demonstrated a significant negative effect on citizens' satisfaction with *meta*-government service (β = -0.115, $p < 0.05$), H4 therefore should be supported. Moreover, organizational failure was negatively related to citizens' satisfaction with *meta*-government service (β = -0.227, $p < 0.001$), supporting H5. Hence, a total of 5 hypotheses were accepted.

4.2. ANN results

ANN can capture both linear and non-linear relationships without normal distribution via the learning process (Sharma et al., 2018). Compared with conventional statistical techniques, ANN can offer higher prediction accuracy (Leong et al., 2020). However, due to its "black box" nature, ANN is unable to examine hypotheses and causal relationships (Sim et al., 2014). Generally, ANN includes three layers: input, hidden, and output. The number of hidden layers is influenced by the complexity of the issue to be solved (Xiong et al., 2022). Sigmoid, hyperbolic tangent, and arctangent are the activation functions of ANN model (Chong, 2013). Recently, an increasing number of studies have used ANN to explore human behavioral outcomes in fields such as online payment services (Sharma et al., 2019), mobile commerce (Liebana-Cabanillas et al., 2017), and mobile government service (Xiong et al., 2022).

4.2.1. Validations of neural networks

In this research, SPSS 23 was used to implement ANN analysis. Similar to the prior studies (Sharma et al., 2019; Leong et al., 2020), those statistically significant independent factors derived from SEM became the input neurons of the neural network analysis. Thus, the ANN model includes five inputs (information failure, service failure, system failure, psychological needs failure, and organizational failure) and one output (citizens' satisfaction). ANN multi-layer perceptron with a feed-forward back-propagation algorithm was employed to examine the ANN model (Hew et al., 2019). In addition, as suggested by the previous studies (Leong et al., 2020; Xiong et al., 2022), this research selected sigmoid as the activation function of the ANN model. Furthermore, the number of hidden nodes was automatically generated. A 10-fold cross-validation approach with 90 % of the samples for the training procedure and 10 % of the samples for the testing procedure was utilized to avoid the possibility of over-fitting (EL Idrissi et al., 2019).

The predictive accuracy of the ANN models was assessed via root mean square error (RMSE). According to Table 5, the RMSE values of the training models (0.106–0.111) and the RMSE values of the testing models (0.096–0.111) are close to 0, suggesting that the ANN models have high levels of predictive accuracy (Lee et al., 2016; Hew et al., 2019). In addition, the average RMSE values of the training and testing models are 0.108 and 0.104, respectively. Hence, there is a good model fit (Leong et al., 2020). Following the approach used by Xiong et al. (2022), we employed the value of R2 to estimate the percentage of variance explained by the ANN model. The result reveals that the input nodes predict citizens' satisfaction with an accuracy of 79.58 %.

4.2.2. Sensitivity analysis

In this research, sensitivity analysis was used to measure the predictive power of each input neuron. We obtained the normalized importance of the neurons by dividing its relative importance by the maximum importance and presenting it in the form of a percentage (Hew et al., 2019). Table 6 shows the results of the sensitivity analysis. Organizational failure is the most powerful predictor, which result is similar to the SEM finding. In addition, psychological needs failure ranks second (87.03 %), followed by system failure (73.70 %), information failure (60.37 %), and service failure (49.63 %). These results are different to the SEM findings. According to prior studies (Sharma et al., 2018; Xiong et al., 2022), the ANN's relatively higher predictive power and its non-compensatory nature might cause the difference between the SEM and ANN findings.

4.3. The moderating effects

Following the approach used by Edwards and Lambert (2007), Wu et al. (2015), Yin et al. (2021), and Zhu et al. (2024b), three hierarchical regressions were conducted to test the moderating roles of technology anxiety. Step 1 (Model 1) included demographic

Table 5
RMSE values for ANN models.

Network	Training			Testing			
	N	SSE	RMSE	N	SSE	RMSE	Total samples
1	358	4.392	0.111	44	0.404	0.096	402
2	363	4.189	0.107	39	0.483	0.111	402
3	358	4.203	0.108	44	0.413	0.097	402
4	361	4.204	0.108	41	0.473	0.107	402
5	360	4.298	0.109	42	0.427	0.101	402
6	362	4.100	0.106	40	0.495	0.111	402
7	368	4.150	0.106	34	0.464	0.117	402
8	360	4.409	0.111	42	0.483	0.107	402
9	359	4.223	0.108	43	0.401	0.097	402
10	361	4.110	0.107	41	0.423	0.102	402
Mean	361	4.228	0.108	41	0.447	0.104	402

Table 6
Sensitivity analysis.

Network	IF	SF	SYF	PNF	OF	Total samples
1	0.188	0.117	0.178	0.234	0.283	402
2	0.190	0.160	0.172	0.228	0.250	402
3	0.127	0.124	0.230	0.252	0.267	402
4	0.132	0.161	0.195	0.235	0.278	402
5	0.177	0.133	0.177	0.220	0.294	402
6	0.162	0.122	0.217	0.233	0.266	402
7	0.186	0.135	0.188	0.240	0.251	402
8	0.170	0.112	0.206	0.241	0.272	402
9	0.132	0.125	0.216	0.249	0.278	402
10	0.161	0.154	0.207	0.213	0.264	402
Average	0.163	0.134	0.199	0.235	0.270	402
Normalized importance	60.37 %	49.63 %	73.70 %	87.03 %	100 %	

information as control variables to decrease the endogeneity problems (Zhu et al., 2024b). The baseline Model 1 was configured as follows:

$$CS = \beta_0 + \beta_1 Gender + \beta_2 Age + \beta_3 Edu + \beta_4 Inc + \beta_5 Exp + \beta_6 IF + \beta_7 SF + \beta_8 SYF + \beta_9 PNF + \beta_{10} OF + e$$

Second, the influences of technology anxiety, information failure, service failure, system failure, psychological needs failure, and organizational failure were entered in Step 2 (Model 2):

$$CS = \beta_0 + \beta_1 Gender + \beta_2 Age + \beta_3 Edu + \beta_4 Inc + \beta_5 Exp + \beta_6 IF + \beta_7 SF + \beta_8 SYF + \beta_9 PNF + \beta_{10} OF + \beta_{11} TA + e$$

Third, all conceptually relevant two-way interaction terms were included in Step 3 (Model 3): Information failure × technology anxiety, service failure × technology anxiety, system failure × technology anxiety, psychological needs failure × technology anxiety, and organizational failure × technology anxiety:

$$CS = \beta_0 + \beta_1 Gender + \beta_2 Age + \beta_3 Edu + \beta_4 Inc + \beta_5 Exp + \beta_6 IF + \beta_7 SF + \beta_8 SYF + \beta_9 PNF + \beta_{10} OF + \beta_{11} TA + \beta_{12} IF*TA + \beta_{13} SF*TA + \beta_{14} SYF*TA + \beta_{15} PNF*TA + \beta_{16} OF*TA + e$$

The results of hierarchical multiple regressions are shown in Table 7. The coefficients for information failure × technology anxiety (β = -0.089, $p < 0.05$), system failure × technology anxiety (β = -0.092, $p < 0.05$), psychological needs failure × technology anxiety (β = -0.101, $p < 0.05$), and organizational failure × technology anxiety (β = -0.083, $p < 0.05$) are significant, indicating that technology anxiety can weaken the influences of these failure types on citizens' satisfaction. Thus, H6a, H6c, H6d, and H6e should be supported. Although the coefficient for service failure × technology anxiety (β = 0.096, $p < 0.05$) is significant, it demonstrates that technology anxiety positively influences the relationship between service failure and citizens' satisfaction with *meta*-government service. Therefore, H6b should be rejected. Fig. 4 shows the moderating effects of technology anxiety.

Table 7
The results of the moderating test.

Variables	Step 1(Model 1)	Step 2 (Model 2)	Step 3 (Model 3)
Gender	−0.147 (t = -1.440)	−0.176 (t = -1.811)	−0.173 (t = -1.797)
Age	0.146 (t = 2.086)	0.127 (t = 1.869)	0.134 (t = 1.987)
Education	−0.056 (t = -0.825)	−0.046 (t = -0.702)	−0.040 (t = -0.628)
Income	−0.001 (t = -0.027)	−0.026 (t = -0.528)	−0.003 (t = -0.069)
Experience	−0.033 (t = -0.455)	−0.027 (t = -0.396)	−0.033 (t = -0.484)
IF		−0.090* (t = -1.865)	−0.108* (t = -2.250)
SF		−0.111* (t = -2.293)	−0.130** (t = -2.710)
SYF		−0.110* (t = -2.277)	−0.100* (t = -2.037)
PNF		−0.157*** (t = -3.301)	−0.127** (t = -2.681)
OF		−0.194*** (t = -4.050)	−0.194*** (t = -4.025)
TA		−0.034 (t = -0.704)	−0.058 (t = -1.207)
IF × TA			−0.089* (t = -2.032)
SF × TA			0.096* (t = 1.980)
SYF × TA			−0.092* (t = -2.082)
PNF × TA			−0.101* (t = -2.157)
OF × TA			−0.083* (t = -1.984)
R^2	0.019	0.129	0.170
ΔR^2	0.007	0.105	0.135
Sample size	402	402	402

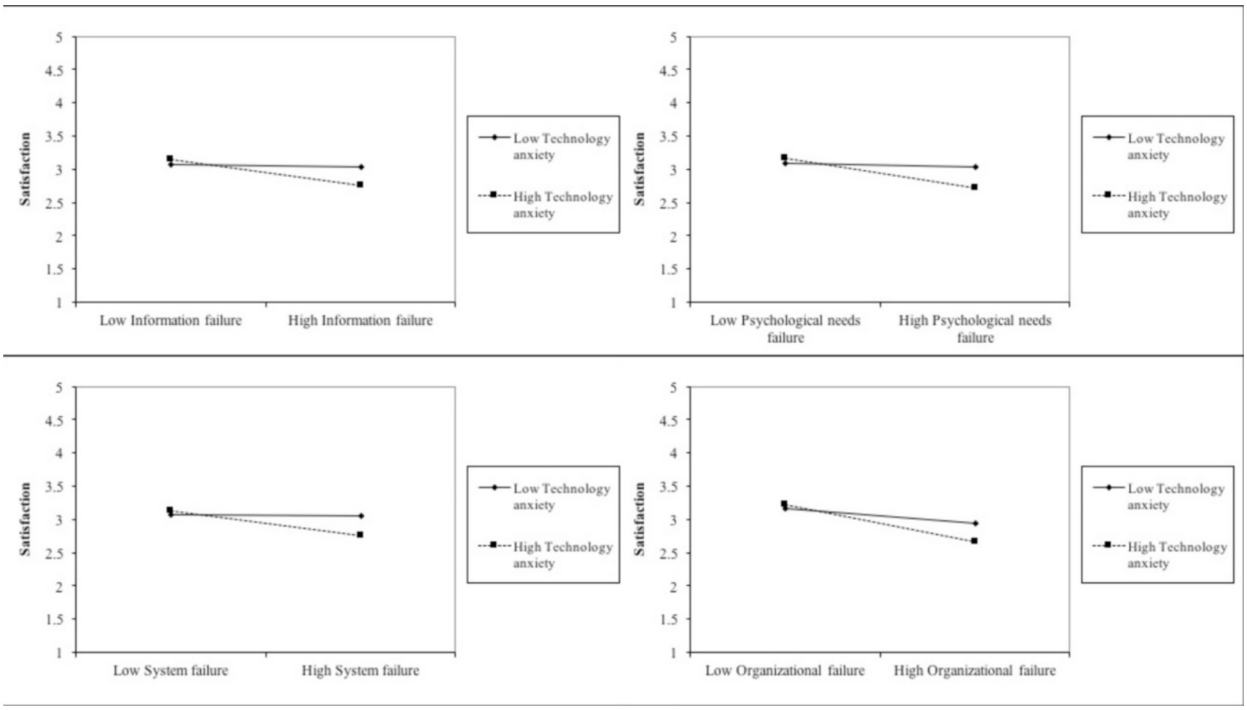

Fig. 4. The moderating roles of technology anxiety.

5. Discussion and implications

5.1. Main findings

In line with previous IS failure research highlighting information failure as a key barrier to user satisfaction (Mustafa et al., 2020), this study revealed that information failure of *meta*-government service exerts a negative impact on citizens' satisfaction. This result emphasizes the importance of individuals perceiving the information services on *meta*-government platforms as accurate, complete, relevant, and up-to-date. Additionally, the findings of this research showed that service failure negatively affects citizens' satisfaction with *meta*-government. This result is aligned with prior IS failure research indicating that people's perceptions of service quality play a key role in shaping their satisfaction with IS services (Tan et al., 2016). According to Li et al. (2021), individuals are more inclined to embrace responsive and reliable IS services. Also, users need touch or feel services to avoid the feeling of emptiness (Mustafa et al., 2020). The findings of this research proved that when citizens believe *meta*-government services are reliable, responsive, and tangible, they are more inclined to feel satisfied and assimilate it into their lives.

Furthermore, this research showed that higher perceived system failure negatively influenced people's satisfaction with *meta*-government service. This result is consistent with previous IS failure research (Mustafa et al., 2020). People's direct experiences with *meta*-government are insufficient. When confronted with novel and unfamiliar technologies like *meta*-government, the worry about system crash and the fear of cyber privacy risks can diminish government services' perceived benefits, decreasing user satisfaction (Al-Adwan et al., 2024). When citizens believe system of *meta*-government is safe and easy to access, navigate, and control, they are more likely to feel satisfied.

Moreover, this research demonstrated that failure to meet psychological needs negatively influences citizens' satisfaction with *meta*-government services. While this finding has not been empirically investigated in the *meta*-government service literature, the results aligns with prior IS research in various contexts, such as social media (Keelson et al., 2024) and online games (Li et al., 2015). The observed negative relationship between psychological needs failure and user satisfaction underscores the opinion that pleasurable, aesthetic, epistemic, and interpersonal interaction experiences on *meta*-government platforms contribute to the level of satisfaction. Psychological demands are core values when experiencing services (Al-Adwan et al., 2024). Citizens who successfully meet their psychological needs during *meta*-government service are more likely to view *meta*-government as a valuable governance tool, thereby increasing their satisfaction.

According to SEM-ANN analysis in this research, organizational failure greatly influenced citizens' satisfaction when using *meta*-government service. This finding has not been empirically demonstrated by previous literature, but it is in line with the argument by Kshetri et al. (2024). In their research, Kshetri et al. (2024) pointed out that China's metaverse projects will involve a higher degree of government participation, which in turn leads to a higher level of regulation and control. The result in this research indicated that citizens in China rely much on the roles of government in administration, legislation, and investment. They expect that government

agencies need to shoulder the responsibilities of planning and managing *meta*-government. Thus, in the foreseeable future, government agencies in China will play an important role in *meta*-government service. When citizens believe that their government is highly involved in the delivery of *meta*-government services and performs well, they are more inclined to feel satisfied.

In addition, several interesting findings were originally revealed through moderating test. In line with our hypotheses, the findings indicated that technology anxiety significantly weakens the influences of information, systems, psychological needs, and organizational failures on citizens' satisfaction. When individuals have a higher level of technology anxiety, their initial expectations of information delivery, system quality, psychological demands, and organizational roles of governments tend to be lower. Therefore, their satisfaction with *meta*-government will not significantly decrease when these types of failures occur.

However, this research found that those with higher levels of technology anxiety tend to feel more disappointed when experiencing non-responsive, unreliable, and intangible service. A possible explanation for this is that people with technology anxiety emphasize the reliability of *meta*-government service. When confronted with unfamiliar technologies like *meta*-government service, they tend to feel more anxious and desire reliability, responsiveness, and empathy because these elements can help release nervousness. If *meta*-government performs unreliably, the feelings of unfamiliarity and anxiety will be enhanced. Ultimately, their dissatisfaction will be increased. The findings of the moderating test indicate that technology anxiety is not a completely negative element in an upcoming metaverse society, as it weakens the relationships between some types of *meta*-government failure and citizens' satisfaction. However, as suggested by the previous research (Li et al., 2021), technology anxiety can cause resistance to change and thus becomes an obstacle to the adoption of a new technology. Hence, government agencies need to consider how to guide people nervous about *meta*-government. Especially, government agencies should concentrate on young generation because they are more willing to embrace the metaverse (Kshetri et al., 2024).

5.2. Theoretical implications

Although numerous studies have been conducted on the success of IS, comparatively very little research has been done related to the failure of IS service. Thus, it has been found that there is a need to investigate service failures in the IS context (Mustafa et al., 2020). As a rising cutting-edge technology, the metaverse has captured the attention of scholars and government agencies worldwide (Kshetri et al., 2024). To the best of our knowledge, this research is one of the earliest attempts to explore the failure of *meta*-government services. The step taken to address the issues of *meta*-government services is small but concrete towards developing research agenda. Specific contributions to theory are elaborated below.

First, this research makes a novel contribution to the unexplored field of *meta*-government service failure, addressing a significant knowledge gap in the existing literature. Leveraging an integrative theoretical framework grounded in DSFM, U&G, and OFDM, this study is among the first empirical investigation of service failure dimensions affecting citizens' satisfaction with *meta*-government.

Second, the exploration of this research is unique in that it contributes to theoretical frameworks in the area of IS service failure. Compared with the numerous theoretical outcomes in the field of IS success, theories and research models that address the issues related to IS failure are limited. DSFM introduced by Mustafa et al. (2020) is an important theoretical model in IS failure research. However, the failure classification (information failure, service failure, and system failure) which DSFM has investigated cannot capture all the failure dimensions of IS services. Specifically, in the context of *meta*-government, service delivery process in a virtual environment provides citizens with pleasurable, aesthetic, epistemic, and interpersonal interaction experiences. Also, government agencies play an important role in the delivery process of such services. Thus, psychological and organizational dimensions should be taken into consideration to explain the failure of *meta*-government services. In this research, we originally integrated DSFM with U&G and OFDM. As a result, psychological needs failure and organizational failure were added as two novel failure classifications. Therefore, this research developed a theoretical model that includes more comprehensive failure classification, which, in turn, makes a valuable contribution to strengthening theoretical frameworks in IS failure.

Third, this is the first study in which the moderating roles of technology anxiety have been explored in the context of *meta*-government, expanding the research boundary of technology anxiety. The findings revealed that technology anxiety significantly weakens the influences of information, system, psychological needs, and organizational failures on citizens' satisfaction, while it shows a positive moderating impact on the relationship between service failure and citizens' satisfaction. These results contribute to a deeper insight into the moderating mechanism of technology anxiety in the context of *meta*-government service failure.

Finally, this research contributes to extending the use of SEM-ANN analysis in a wider field. Unlike most existing e-government studies that employed SEM, this research utilized a hybrid SEM-ANN approach that can identify both linear and non-linear relationships to offer a holistic understanding of the failure of *meta*-government services. As suggested by Xiong et al. (2022), the validity and robustness of the research findings can be improved through SEM-ANN analysis. In this research, the ANN results reinforced the SEM findings. Future studies on *meta*-government are recommended to employ SEM-ANN approach as relationships are likely to be non-linear. In this way fresh insights and new knowledge can be obtained.

5.3. Managerial implications

The findings in this study will be beneficial to *meta*-government service providers in multiple ways. First, to avoid information failure, it is important to ensure that *meta*-government platforms provide accurate, complete, relevant, and up-to-date information. Meta-government platforms should apply an information updating mechanism to make sure the data is timely. Human-robot cooperation can be utilized to conduct double-checks when updating information. In the first round, AI can be used to identify and list problematic information. In the second round, humans should check the information by themselves.

Second, proto-metaverse platforms must begin with simple and citizen-focused services to increase the service success rate and enhance perceived reliability. Additionally, marketing and promotions should highlight the tangible benefits citizens will obtain from *meta*-government. More comprehensive datasets can be used to train AI-based chatbots to improve responsive speed and accuracy. More importantly, regular usability testing should be conducted to survey citizens and understand their suggestions about service quality.

Third, training, support programs, immersive tutorials, and community activities should aid citizens in learning and getting familiar with *meta*-government systems. Security and privacy should be a top priority when offering *meta*-government services. Government agencies should prioritize risk mitigation initiatives to reduce the impacts of cybersecurity and privacy risks, including encrypting citizen data, using anonymous ID, establishing strict data protocols, and conducting regular security audits. In addition, hardware, software, and other infrastructure should be continually updated to keep the system stable. A disaster recovery plan should be made to deal with a sudden system crash. Furthermore, *meta*-government service providers also need to develop *meta*-government apps to make service delivery more accessible.

Fourth, government agencies should make *meta*-government platforms more enjoyable to use by incorporating gamification, social interaction features, and aesthetically pleasing interfaces, as psychological needs failure decreases citizens' satisfaction. Moreover, some small learning programs can be conducted to offer new knowledge during the service delivery. For example, knowledge about *meta*-government or government policies can be displayed through manga during the system loading. Usability testing should include perceived enjoyment metrics to reveal opportunities to increase this factor over time through new features and rewards.

Fifth, a professional official department that concentrates on *meta*-government is needed. Both central and local governments should earmark special funds to develop *meta*-government per year. Moreover, the opinion of regulating *meta*-government development according to law should be put forward because the metaverse is not a place outside the law. It is suggested that the strategic layout of law-based governance in *meta*-government be accelerated. Legislation of *meta*-government needs to focus on the main legal conundrums, including data governance, virtual property, cybercrime, and platform liability. Legislative means such as enactment, reform, abolition, and interpretation should be utilized to promote regulations in the main areas of *meta*-government.

Finally, although technology anxiety is not a completely negative element in an upcoming metaverse society, government agencies should consider how to guide those who feel anxious about technology. For instance, incorporating citizen feedback and insights through surveys, focus groups, and social listening can identify fields of anxiety. Support programs should be implemented to explain that *meta*-government adheres to the principle of safe and controllable development. With proper change initiatives highlighting the usefulness and value of *meta*-government, while decreasing threats and friction, people's anxieties can be released. In addition, *meta*-government platforms also need to keep human agent services for those with technology anxiety.

6. Conclusion and limitations

Meta-government is different from most of e-government services. Currently, e-government services are generally provided through flat pages or applications. However, the metaverse has a virtual space that can reproduce various environment in the real world. Users are allowed to freely move and explore in the metaverse and interact in real-time with others. By integrating reality and virtuality, *meta*-government provides an experience of immersion and realism. Despite these advantages, the "true" metaverse is still a vision because key challenges still remain. The research objective of this study is to understand the influences of different failure types on citizens' satisfaction with *meta*-government services. To the best of our knowledge, this study is one of the earliest attempts to address the problem related to the failure of the *meta*-government services.

Drawing on DSFM, U&G, and OFDM, this research developed an integrative framework to conduct the empirical analysis. First, five failure types were identified: information, service, system, psychological needs, and organizational failures. Second, through a SEM-ANN analysis, this study revealed that information, service, system, psychological needs, and organizational failures negatively influence citizens' satisfaction. Within all the failure types, organizational failure showed the most powerful influence. Third, technology anxiety can weaken the influences of information, system, psychological needs, and organizational failures on citizens' satisfaction while enhancing the association between service failure and citizens' satisfaction. Based on the research findings above, the research objective was accomplished. The findings in this study are new in understanding the failure of *meta*-government services.

While this study contributes to initial theoretical and practical insights, it has limitations. First, the majority of respondents in this research were under 31 (88.9 %). Thus, the findings mainly reflected young users' perceptions. Second, this study only collected data in China, and therefore the findings may not be generalizable to other countries. For instance, citizens in China tend to highlight the role of government agencies while other countries may not (Kshetri et al., 2024). Future studies can compare across demographic and cultural segments. Third, because a single study cannot exhaustively include all possible failure types of services, this research only investigated five failure classifications of *meta*-government. Thereby, future studies should explore additional potential failure types to extend the research model. Finally, a cross-sectional approach was used in this study. Future research can contemplate employing a longitudinal approach to test the temporal effects.

CRediT authorship contribution statement

Yonghan Zhu: Writing – original draft, Software, Resources, Methodology, Investigation. **Marijn Janssen:** Writing – review & editing, Formal analysis, Conceptualization.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. . Measurements and sources

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Construct	Item	Source
Information failure (IF)	IF1. The *meta*-government platform provides inaccurate information. IF2. The *meta*-government platform provides incomplete and incomprehensive information. IF3. The *meta*-government platform provides irrelevant information. IF4. The information provided by the *meta*-government platform is not up-to-date.	Tan et al. (2016)
Service failure (SF)	SF1. The *meta*-government platform fails to timely respond to my interest. SF2. The services provided by the *meta*-government platform are not reliable. SF3. The *meta*-government platform provides visually appealing services, interaction, and facilities. SF4. The *meta*-government platform fails to understand my demands and give individual attention.	Mustafa et al. (2020)
System failure (SYF)	SYF1. I cannot access the *meta*-government platform and services whenever I want. SYF2. I need spend more time on the *meta*-government platform because its navigation is useless. SYF3. The *meta*-government platform usually delays due to slow speed or system crash. SYF4. There are many cyber risks in the *meta*-government platform and I feel insecure.	Mustafa et al. (2020)
Psychological needs failure (PNF)	PNF1. The *meta*-government platform fails to provide me with new knowledge. PNF2. The *meta*-government platform fails to provide enjoyable and entertaining services. PNF3. I cannot experience a feeling of aesthetics when using the *meta*-government platform. PNF4. The *meta*-government platform fails to provide an effective way to interact with others.	Introne et al. (2018); Thompson et al. (2019)
Organizational failure (OF)	OF1. The governments in China fail to establish professional administrative departments to plan, manage, and develop the *meta*-government. OF2. There is a lack of legislation about *meta*-government in China. OF3. The governments in China will not continuously invest on *meta*-government.	Goulielm-os (2005)
Technology anxiety (TA)	TA1. I have difficulty understanding most technological matters relating to cutting-edge technologies, such as AI, VR, AR, and the metaverse. TA2. I usually make mistakes when using cutting-edge technologies. TA3. In my opinion, technologies are unpredictable and uncontrollable.	Li et al. (2021)
Citizens' satisfaction (CS)	CS1. I like to use the services provided by the *meta*-government platform. CS2. It is wise to use the services provided by the *meta*-government platform. CS3. I am pleased with the experience of using the *meta*-government platform. CS4. Overall, I am satisfied with the *meta*-government platform.	Zhu et al. (2022)

Data availability

Data will be made available on request.

References

Ahn, S., Jin, B.E., Seo, H., 2024. Why do people interact and buy in the Metaverse? Self-expansion perspectives and the impact of hedonic adaption. J. Bus. Res. 175, 114557.
Allam, Z., Sharifi, A., Bibri, S., Jones, D., Krogstie, J., 2022. The metaverse as a virtual from of smart cities: Opportunities and challenges for environmental, economic, and social sustainability in urban futures. Smart Cities 5 (3), 771–801.
Al-Adwan, A.S., 2024. The government metaverse: Charting the coordinate of citizen acceptance. Telematics Inform. 88, 102109.
Apuke, O.D., Omar, B., 2021. User motivation in fake news sharing during the COVID-19 pandemic: An application of the uses and gratification theory. Online Inf. Rev. 45 (1), 220–239.
Ashfaq, M., Yun, J., Yu, S., Loureiro, S.M.C., 2020. I, Chatbot: Modeling the determinants of users' satisfaction and continuance intention of AI-powered service agents. Telematics Inform. 54, 101473.
Baek, K., Holton, A., Harp, D., Yaschur, C., 2011. The links that bind: uncovering novel motivations for linking on Facebook. Comput. Hum. Behav. 27 (6), 2243–2248.
Bertot, J., Estevez, E., Janowski, T., 2016. Universal and contextualized public services: Digital public services innovation framework. Gov. Inf. Q. 33 (2), 211–222.
Brislin, R.W., 1970. Back-translations for cross-cultural research. J. Cross Cult. Psychol. 1 (3), 185–216.

Capatina, A., Patel, N.J., Mitrov, K., Cristea, D.S., Micu, A., Micu, A.E., 2024. Elevating students' lives through immersive learning experiences in a safe metaverse. Int. J. Inf. Manag. 75, 102723.
Chen, L., Tao, S., Xie, X., Huang, W., Zhu, W., 2024. The evaluation of innovation efficiency and analysis of government subsidies influence – Evidence from China's metaverse listed companies. Technol. Forecast. Soc. Chang. 201, 123213.
Chen, T., Guo, W., Gao, X., Liang, Z., 2021. AI-based self-service technology in public service delivery: User experience and influencing factors. Gov. Inf. Q. 38 (4), 101520.
Cheng, J.W., Mitomo, H., 2017. The underlying factors of the perceived usefulness of using smart wearable devices for disaster applications. Telematics Inform. 34 (2), 528–539.
Choi, S., Mattila, A.S., 2008. Perceived controllability and service expectations: in uences on customer reactions following service failure. J. Bus. Res. 61 (1), 24–30.
Choi, T., Kumar, S., Yue, X., Chan, H., 2022. Disruptive technologies and operations management in the industry 4.0 era and beyond. Prod. Oper. Manag. 31 (1), 9–31.
Chong, A.-Y.-L., 2013. Predicting m-commerce adoption determinants: A neural network approach. Expert Syst. Appl. 40 (2), 523–530.
Delone, W.H., McLean, E.R., 2003. The DeLone and McLean model of information systems success: A ten-year update. J. Manag. Inf. Syst. 19 (4), 9–30.
DeLone, W.H., McLean, E.R., 1992. Information systems success: The quest for the dependent variable. Inf. Syst. Res. 3 (1), 60–95.
Doherty, N.F., King, M., 1998. The consideration of organizational issues during the systems development process: an empirical analysis. Behav. Inf. Technol. 17 (1), 41–51.
Dunne, A., Lawlor, M.A., Rowley, J., 2010. Young people's use of online social networking sites - a uses and gratifications perspective. J. Res. Indian Med. 4 (1), 46–58.
Edwards, J.R., Lambert, L.S., 2007. Methods for integrating moderation and mediation: a general analytical framework using moderated path analysis. Psychol. Methods 12 (1), 1–22.
Idrissi, E.L.T., Idri, A., Bakkoury, Z., 2019. Systematic map and review of predictive techniques in diabetes self-management. Int. J. Inf. Manag. 46 (6), 263–277.
Eneko, E., Chinh, H., Rodriguez, A., Luigi, D., 2020. Modelling user satisfaction in public transport systems considering missing information. Transportation 47 (6), 2903–2921.
Fornell, C., Larcker, D., 1981. Evaluating structural equation models with unobservable variables and measurement error. J. Mark. Res. 18 (1), 39–50.
Gesk, T.S., Leyer, M., 2022. Artificial intelligence in public services: When and why citizens accept its usage. Gov. Inf. Q. 39, 101704.
Gohary, A., Hamzelu, B., Alizadeh, H., 2016. Please explain why it happened! how perceived justice and customer involvement affect post co-recovery evaluations: a study of Iranian online shoppers. J. Retail. Consumer Services 31, 127–142.
Goulielmos, M., 2005. Applying the organizational failure diagnosis model to the study of information systems failure. Disaster Prev. Manag. 14 (3), 362–377.
Goulielmos, M., 2003. Outlining organizational failure in information systems development. Disaster Prevent. Manage. 12 (4), 319–327.
Hair, J.F., Risher, J.J., Sarstedt, M., Ringle, C.M., 2019. When to use and how to report the results of PLS-SEM. Eur. Bus. Rev. 31 (1), 2–24.
Hajian, A., Daneshgar, S., Sadeghi, K., Ojha, D., Katiyar, G., 2024. From theory to practice: Empirical perspectives on the metaverse's potential. Technol. Forecast. Soc. Chang. 201, 123224.
Hew, J.-J., Leong, L.-Y., Tan, G.-W.-H., Ooi, K.-B., Lee, V.-H., 2019. The age of mobile social commerce: An artificial neural network analysis on its resistances. Technol. Forecast. Soc. Chang. 144, 311–324.
Huang, L.Y., Hsieh, Y.J., 2011. Predicting online game loyalty based on need gratification and experiential motives. Internet Res. 21 (5), 581–598.
Introne, J., Gokce Yildirim, I., Iandoli, L., DeCook, J., Elzeini, S., 2018. How people weave online information into pseudoknowledge. Social Media Soc. 4 (3).
Jahan, N., Hoque, S., Hossain, M.A., Hoon, J.S., Pipul, M.M.U.A., 2024. SNS citizenship behavior based on D&M information system success model and social capital theory: Mediating role of subjective well-being. Heliyon 10, e29982.
Joo, J., Sang, Y., 2013. Exploring Koreans' smartphone usage: An integrated model of the technology acceptance model and uses and gratifications theory. Comput. Hum. Behav. 29 (6), 2512–2518.
Jung, D., 2019. "Assessing citizen adoption of e-government initiatives in Gambia: A validation of the technology acceptance model in information systems success." A critical article review, with questions its publishers. Gov. Inf. Q. 36, 5–7.
Kaur, P., Dhir, A., Rajala, R., Dwivedi, Y., 2018. Why people use online social media brand communities. A consumption value theory perspective. Online Inf. Rev. 42 (2), 205–221.
Keelson, S.A., Bruce, E., Egala, S.B., Amoah, J., Jibril, A.B., 2024. Driving forces of social media and its impact on tourists' destination decisions: a uses and gratification theory. Cogent Social Sci. 10 (1), 2318878.
Kim, H., So, K.K.F., 2023. The evolution of service failure and recovery research in hospitality and tourism: An integrative review and future research directions. Int. J. Hosp. Manag. 111, 103457.
Kim, Y., Wang, Q., Roh, T., 2021. Do information and service quality affect perceived privacy protection, satisfaction, and loyalty? Evidence from a Chinese O2O-based mobile shopping application. Telematics Inform. 56, 101483.
Kshetri, N., Dwivedi, Y.K., Janssen, M., 2024. Metaverse for advancing government: Prospects, challenges and a research agenda. Gov. Inf. Q. 41, 101931.
Kumar, A., Shankar, A., Nayal, P., 2024. Metaverse is not my cup of tea! An investigation into how personality traits shape metaverse usage intentions. J. Retail. Consum. Serv. 77, 103639.
Lee, C.S., Ma, L., 2012. News sharing in social media: the effect of gratifications and prior experience. Comput. Hum. Behav. 28 (2), 331–339.
Lee, H.J., Yang, K., 2013. Interpersonal service quality, self-service technology (SST) service quality, and retail patronage. J. Retail. Consum. Serv. 20 (1), 51–57.
Lee, V.H., Foo, A.T.L., Leong, L.Y., Ooi, K.B., 2016. Can competitive advantage be achieved through knowledge management? A case study on SMEs. Expert Syst. Appl. 65, 136–151.
Leong, L., Hew, T., Ooi, K., Wei, J., 2020. Predicting mobile wallet resistance: A two-staged structural equation modeling-artificial neural network approach. Int. J. Inf. Manag. 51, 102047.
Leung, D., Law, R., Van Hoof, H., Buhalis, D., 2013. Social media in tourism and hospitality: A literature review. J. Travel Tour. Mark. 30 (1–2), 3–22.
Lewis, B.R., Spyrakopoulos, S., 2001. Service failures and recovery in retail banking: the customers' perspective. Int. J. Bank Mark. 19 (1), 37–48.
Li, H., Liu, Y., Xu, X., Heikkila, J., van der Heijden, H., 2015. Modeling hedonic is continuance through the uses and gratifications theory: An empirical study in online games. Comput. Hum. Behav. 48, 261–272.
Li, L., Lee, K.Y., Emokpae, E., Yang, S., 2021. What makes you continuously use chatbot services? Evidence from chinese online travel agencies. Electron. Mark. 31, 575–599.
Liebana-Cabanillas, F., Marinkovic, V., Kalinic, Z., 2017. A SEM-neural network approach for predicting antecedents of m-commerce acceptance. Int. J. Inf. Manag. 37, 14–24.
Lnenicka, M., Rizun, N., Alexopoulos, C., Janssen, M., 2024. Government in the metaverse: Requirements and suitability for providing digital public services. Technol. Forecast. Soc. Chang. 203, 123346.
Ma, Y., 2021. Elucidating determinants of customer satisfaction with live-stream shopping: An extension of the information systems success model. Telematics Inform. 65, 101707.
Meuter, M.L., Ostrom, A.L., Bitner, M.J., Roundtree, R., 2003. The influence of technology anxiety on consumer use and experiences with self-service technologies. J. Bus. Res. 56 (11), 899–906.
Mirza, R., Lytras, M.D., Alzamzami, O., Khuzayem, L.A., Alharbi, H., Alshammari, S., Bafail, A., Basbrian, A., Alharbi, E., Bajnaid, N., Yusuf, N., AlHalabi, W., 2024. Clustering potential metaverse users with the use of a value-based framework: Exploiting perceptions and attitudes on the use and adoption of metaverse for bold propositions. Telematics Inform. 87, 102074.
Mustafa, S.Z., Kar, A.K., Jassen, M., 2020. Understanding the impact of digital service failure on users: Integrating Tan's failure and DeLone and McLean's success model. Int. J. Inf. Manag. 53, 102119.
Nguyen, L., Duc, D., Dang, T., Nguyen, D., 2023. Metaverse banking service: Are we ready to adopt? a deep learning-based dual-stage SEM-ANN analysis. Hum. Behav. Emerging Technol. 10.

Oliver, R.L., 1980. A cognitive model of the antecedents and consequences of satisfaction decisions. J. Mark. Res. 17 (4), 460–469.
Orden-Mejía, M., Huertas, A., 2022. Analysis of the attributes of smart tourism technologies in destination chatbots that influence tourist satisfaction. Curr. Issue Tour. 25 (17), 2854–2869.
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. J. Appl. Psychol. 88 (5), 879–903.
Ruchkin, A., Kruzhkova, T., Rushitskaya, O., & Dyuzelbayeva, G., 2021. E-government as an effective way of interaction between government authorities and the population. In XV International Conference "Russian Regions in the Focus of Changes, (ICRRFC 2020)".
Seo, D., Bernsen, M., 2016. Comparing attitudes toward e-government of non-users versus users in a rural and urban municipality. Gov. Inf. Q. 33 (2), 270–282.
Sharma, S.K., Al-Badi, A., Rana, N.P., Al-Azizi, L., 2018. Mobile applications in government services (mG-App) from user's perspectives: A predictive modelling approach. Gov. Inf. Q. 35 (4), 557–568.
Sharma, S.K., Sharma, H., Dwivedi, Y.K., 2019. A hybrid SEM-neural network model for predicting determinants of mobile payment services. Inf. Syst. Manag. 36 (3), 243–261.
Shin, D., 2022. The actualization of meta affordances: conceptualizing affordance actualization in the metaverse games. Comput. Hum. Behav. 133, 107292.
Sim, J.J., Tan, W.H., Wong, J.C.J., Ooi, K.B., Hew, T.S., 2014. Understanding and predicting the motivators of mobile music acceptance — a multi-stage MRA-artificial neural network approach. Telematics Inform. 31 (4), 569–584.
Smith, A.K., Bolton, R.N., Wagner, J., 1999. A model of customer satisfaction with service encounters involving failure and recovery. J. Mark. Res. 36 (3), 356–372.
Tan, C.W., Benbasat, I., Cenfetelli, R.T., 2016. An exploratory study of the formation and impact of electronic service failures. MIS Q. 40 (1), 1–29.
Tan, W.H., Ooi, K.B., Leong, L.Y., Lin, B., 2014. Predicting the drivers of behavioral intention to use mobile learning: A hybrid SEM-neural networks approach. Comput. Hum. Behav. 36, 198–213.
Teng, C., 2018. Look to the future: Enhancing online gamer loyalty from the perspective of the theory of consumption values. Decis. Support Syst. 114, 49–60.
Thompson, C., 2022. Japan to invest in Metaverse and NFT expansion, Oct 4. https://www.coindesk.com/web3/2022/10/04/japan-to-invest-in-Metaverse-and-nft-expansion/.
Thompson, N., Wang, X., Daya, P., 2019. Determinants of news sharing behavior on social media. J. Comput. Inf. Syst. 1 (1), 1–9.
Wan, X., Zhang, G., Yuan, Y., Chai, S., 2023. How to drive the participation willingness of supply chain members in metaverse technology adoption? Appl. Soft Comput. 145, 110611.
Wang, Y., Han, M., Wang, Y., Shafiee, S., 2023. An empirical study on customers' behavior of passive and active resistance to innovation. Econ. Res.—Ekonomska Istrăzivanja 36 (1), 2179515.
Wray, S. (2023). These cities want in on the Metaverse Twitter Facebook LinkedIn Email 16 March by. https://cities-today.com/these-cities-want-in-on-the-Metaverse/.
Wilson, M.L., Huggins-Manley, A.C., Ritzhaupt, A.D., Ruggles, K., 2023. Development of the abbreviated technology anxiety scale (ATAS). Behav. Res. Methods 55, 185–199.
Wouters, S., Janssen, M., Lember, V., Crompvoets, J., 2023. Strategies to advance the dream of integrated digital public service delivery in inter-organizational collaboration networks. Gov. Inf. Q. 40, 101799.
Wu, Y., Wu, J., Chen, Y., Han, L., Han, P., Wang, P., Gao, F., 2015. Shyness and school adjustment among Chinese preschool children: examining the moderating effect of gender and teacher– child relationship. Early Educ. Dev. 26 (2), 149–166.
Xiong, L., Wang, H., Wang, C., 2022. Predicting mobile government service continuance: A two-stage structural equation modeling-artificial neural network approach. Gov. Inf. Q. 39, 101654.
Yfantis, V., Ntalianis, K., 2022. Exploring the potential adoption of metaverse in government. Springer, Singapore, pp. 815–824.
Yin, C., Zhao, W., Cherubini, F., Pereira, P., 2021. Integrate ecosystem services into socio-economic development to enhance achievement of sustainable development goals in the post-pandemic era. Geogr. Sustainability 2 (1), 68–73.
Zhang, X., Zhang, Z., 2024. Leaking my face via payment: Unveiling the influence of technology anxiety, vulnerabilities, and privacy concerns on user resistance to facial recognition payment. Telecommun. Policy 48, 102703.
Zhang, B., Zhu, Y., 2021. Comparing attitudes towards adoption of egovernment between urban users and rural users: an empirical study in chongqing municipality, China. *Behav. Inform. Technol.* 40 (11), 1154–1168.
Zhu, X., Liu, Z., Wu, G., Tian, H., 2024a. How to acquire customer loyalty in online retailing industry? An empirical study from service recovery perspective. Electron. Commer. Res. Appl. 65, 101385.
Zhu, Y., Li, J., Han, X., Wang, R., Wang, C., Pu, C., 2024b. Embracing the future: perceived value, technology optimism and VR tourism behavioral outcomes among generation Z. Int. J. Human-Computer Interaction.
Zhu, Y., Janssen, M., Wang, R., Liu, Y., 2022. It is me, chatbot: Working to address the COVID-19 outbreak-related mental health issues in China. User experience, satisfaction, and influencing factors. Int. J. Human–computer Interaction 38 (12), 1182–1194.
Zhu, Y., Wang, R., Zeng, R., Pu, C., 2023. Does gender really matter? Exploring determinants behind consumers' intention to use contactless fitness services during the COVID-19 pandemic: A focus on health and fitness apps. Internet Res. 33 (1), 280–307.