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Unveiling Psychosocial Factors Influencing Metaverse-associated App Adoption: Acumens from fsQCA Approach

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Competing Interest

My co-authors and I do not have any interests that might be interpreted as influencing the research "Conflicts of interest notice".

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Abstract

The Metaverse represents a fusion of the physical and digital worlds, heralding the next evolution in the manufacturing and services sector. Given the rapid proliferation of Metaverse-associated apps (MAPPs), gaining a profound understanding of consumer proclivities and intentions to use them is crucial. However, existing Metaverse literature primarily uses symmetric variance-based approaches, which have not fully captured the complex interactions among factors influencing adoption. We address this gap by examining how various psychosocial factors and their configurations influence MAPPs adoption through the lens of configuration and complexity theories. The research results were based on a sample of 372 Chinese consumers analyzed using PLS-SEM, NCA, and fsQCA, identifying seven distinct solutions, each characterized by a unique combination of personality, motivational, social, and functional traits. This study adds to the Metaverse literature by offering a robust theoretical framework to explain the asymmetric impact of psychosocial factors on MAPP adoption.

Keywords: Metaverse, Parasocial factors, fsQCA, Configurational model, Asymmetric impact

1. Introduction

The Metaverse is an alternate domain created by virtual reality (VR) technology that blurs the line between physical and digital existence, enhancing sociability, productivity, and recreational pursuits (Chakraborty et al., 2024; Gursoy et al., 2023; Yu, 2024). In the first five months of 2022, investments in the development of Metaverse infrastructure, applications, and technology exceeded \$120 billion (McKinsey, 2022). Chan et al. (2023) estimated that this technology could generate an economic advantage of \$5 trillion by 2030. With these substantial progressions, Metaverse-associated apps (MAPPs) have recently been introduced by businesses to profoundly reshape human experiences in the virtual context, overcoming the limitations of physical environments (Njoku et al., 2023; Tlili et al., 2023).

Since MAPPs are very recent technological developments, their adoption is still embryonic. One issue regarding these MAPPs involves social and psychological concerns stemming from potential differences in time perception, as individuals might experience diminished awareness and reality of their physical bodies (Arpaci et al., 2022; Zhao et al., 2022). This is because the virtual universe and the concept of establishing a second life are seen as the evolving reality of the world, particularly in light of the digital explosion (Arpaci et al., 2022). Although previous studies have primarily focused on MAPPs adoption within a broad framework, affirming the essential benefits related to functionality and competitive advantage (Wang et al., 2023) they have overlooked the social and emotional determinants related to the adoption. Given social and psychological concerns related to MAPPs adoption, evaluating all the primary functional, social, personality, and motivational determinants is imperative.

Another concern is that the factors influencing MAPPs adoption are not entirely independent and often interact and influence one another in practical adoption scenarios (Shah et al., 2023; Woodside, 2021). However, neglecting these interrelationships, most recent research has employed symmetric variance-based approaches by utilizing traditional theories and models to examine factors influencing the adoption of the Metaverse and related services by considering each factor separately (Hajian et al., 2024; Mirza et al., 2024; Oh et al., 2023). However, it is essential to acknowledge that a systematic dependency solely on net effects may result in misleading conclusions, necessitating an examination of the intricate connections among various dimensions collectively.

To address these two gaps, we first create an intricate framework to elucidate the impact of psychosocial factors on user adoption behavior. Since the PLS-SEM is limited in its ability to clarify intricate causal linkages among several interrelated antecedents, researchers suggest using a mixed approach of combining PLS-SEM, NCA, and fsQCA (Sukhov et al., 2023). To this end, PLS-SEM is used to uncover the interrelation among critical factors (Sarstedt et al., 2021) and NCA to characterize the nature and the minimum threshold level of variables (Dul, 2016). Finally, fsQCA is used to determine the appropriate arrangements for particular outcome conditions (Yuan et al., 2024). Sukhov et al. (2023) point out that these approaches facilitate understanding causal complexity. Since this research aims to understand the psychosocial factors that affect use behavior, the data will be analyzed using the PLS-SEM, NCA, and fsQCA approaches to generate the marketing and promotion of MAPPs. These four psychosocial dimensions include: functional ((perceived usefulness (PU) and privacy (PP)), social ((interactivity (SI) and presence (SP)), motivational ((gamification (GM) and social recognition (SR)), and personality ((locus of control (LC) and openness to experience (OE)). More specifically, in our effort, we aimed to address the following research objectives:

- To evaluate the cumulative influence of psychosocial elements (e.g., Perceived Usefulness, Perceived Privacy, Social Interaction, Social Presence, Social Recognition, Gamification, Openness, and Locus of Control) on MAPPs adoption via hypotheses testing using structural equation modelling (PLS-SEM).
- To identify essential and adequate strategies for MAPPs adoption by using asymmetric frameworks like NCA and fsQCA to ascertain measurable thresholds of significant factors.
- Utilizing predictive models developed through analytical methods to validate and enhance the implementation of tactics aimed at increasing MAPPs adoption among consumers.

Our findings contribute to the burgeoning body of literature on Metaverse in three vital ways. First, this research paper is firmly grounded in theory, unlike much of the existing literature, which has often overlooked robust theoretical frameworks. It integrates configurational and complexity theories within the MAPPs context to systematically study the factors influencing its adoption. By incorporating complexity theory, the study aims to enhance understanding of the overarching patterns in MAPPs adoption, while configuration theory helps identify specific configurations or patterns within this complex framework (Lewin, 1992; Woodside, 2021; Xie & Tsai, 2021). Second, our approach is innovative because it employs PLS-SEM, NCA, and fsQCA by conducting a constructive analysis to offer managerial insights, whereas much of the prior literature has relied on symmetric variance-based methods that examine factors influencing Metaverse adoption individually (Navarro-García et al., 2024). This study adds to the Metaverse literature by identifying combinations of factors that significantly correlate with MAPPs adoption and helps researchers better address consumers' unique requirements and preferences. Finally, by identifying various configurations, these results will help business firms enhance their ability to design and develop innovative MAPPs that align with user needs and adoption trends (Navarro-García et al., 2024).

The rest of the paper is structured as follows. The following section critically evaluates the theoretical background and establishes the foundation for the proposed research model. The next section describes the research methods, followed by a thorough discussion of the study findings. Finally, the empirical findings are discussed and compared with the extant literature, and through that, the theoretical contributions and practical implications are presented.

2. Theoretical Framework and Research Model

In recent years, the increasing interest in the Metaverse has prompted scholars to analyze the factors influencing its adoption, primarily employing conventional research approaches. For instance, Pal and Arpnikanondt (2024) and Zallio and Clarkson (2022) utilized the quantitative approach within the framework of social determination theory, finding that user responses from VR-based Metaverse applications indicate that concerns related to autonomy and competence serve as key motivators for escapism and attachment to virtual worlds. Using the technology adoption model (TAM), other scholars (e.g., (Wu & Yu, 2023); Xi et al. (2024)) revealed that extended reality through Metaverse has the potential to provide an experience that is equal to or even better than traditional purchasing behavior in terms of both practical and pleasurable features, despite a slightly lower perception of usability. Arpaci et al. (2022) also investigated the social sustainability of the Metaverse utilizing UTAUT concepts to examine performance expectancy, social influence, hedonic motivation, price value, habit, agreeableness, neuroticism, and openness, all substantially impacting social sustainability. In the same way, the study of Sun et al. (2023) established an integrated model utilizing Yee's motivations and the Proteus effect to investigate individuals' intentions to engage in metaverse-related massive multiplayer online role-playing games. The data from 441 respondents were examined using a structural equation modelling, which revealed that the Proteus effect favorably impacted players' intents to engage in the Metaverse game via mediations of social, immersion, achievement motives, and enjoyment. In another research, Nan et al. (2023) explored players' intentions to continue playing massively multiplayer online virtual games by developing a model grounded on social identity theory and flow theory. Further, an analysis of survey-based data from 375 Korean players revealed that avatar attractiveness, originality, and subculture appeal strongly correlated with the perception of avatar coolness. Moreover, the uniqueness of avatars enhances the attractiveness of avatar subcultures. However, a meticulous look at the inter-related and cumulative effects of each of these variables is necessary to obtain a holistic comprehension of the adoption process (Qinqin et al., 2023).

Accordingly, this article seeks to bridge the literature gap on the asymmetric relationships of MAPPs adoption by systematically determining and exploring the antecedents of functionality, social, motivation, and personality. In this direction, we employ configuration and complexity theory to enrich our understanding of the multiple and mutually dependent components of MAPPs that nonlinear models cannot explain adequately (Yuan et al., 2024). For instance, TAM, TPB, and

UTAUT highlight the impact of individual structures, however, configuration theory explains how individual structures mutually interact (Wang et al., 2023). Similarly, the complexity theory elucidates how these interactions result in unforeseeable or nonlinear outcomes (Shah et al., 2023). To put it differently, complexity theory elucidates the context in which these variables transform and adjust over time in response to user feedback and the dynamic nature of the MAPPs, whereas configurational theory provides practical procedures for enhancing these elements through strategic arrangements of virtual attributes (Gao et al., 2024). This integration approach of complexity and configurational theories also helps in utilizing concepts of equifinality and causal asymmetry to uncover beneficial outcomes through various combinations (Wang et al., 2023). The manifestation of a result can be ascribed to different combinations (i.e., configurations, paths, or equations) of preceding circumstances, like how a goal can usually be achieved through separate routes (Foroughi et al., 2024).

2.1. Functional Factors (Perceived Usefulness and Perceived Privacy)

Initially, this study explores the basic elements of functional components, perceived usefulness (PU), and privacy (PP) in using MAPPs. The research by Wang et al. (2023) indicates that proficiency in functional components does not inherently lead to just fast growth and usefulness since consumer concerns over the adoption of new technology differ from one another. The growth of MAPPs also raises uncertainties about data privacy and the growing intricacy of technology (Mirza et al., 2024). Therefore, users are more persuaded to admit MAPPs that are both useful, safe, and easy to use (Arpaci et al., 2022; Aslam et al., 2022). In order to improve the depiction of user experience for these applications, Nan et al. (2022) also integrated various concepts into the causal model, including hedonic motivation, system and service quality, perceived cost, and variety. These findings indicated that subcultural appeal and originality play a much greater role in individuals' perception of consoles than attractiveness in coolness theory. Similarly, an equivalent level of significance pertains to the security of AI and MAPPs (Al-Emran & Deveci, 2024; Fotouhi et al., 2020; Tlili et al., 2024; Wang et al., 2023). When individuals perceive a potential threat to the security of their personal information, they often show reluctance to continue using these technologies (Chen et al., 2023; Eltanbouly et al., 2024). In collectivist cultures such as China, there is less focus on individual wants in favor of communal advantages. In China, advanced technology applications are often seen as instruments for improving society's efficiency, possibly minimizing the significance of individual autonomy. Chinese consumers' profound

technological knowledge and robust faith in governmental laws and corporations mitigate privacy issues (Husairi & Rossi, 2024; Wong et al., 2015). However, MAPPs users will evaluate the likelihood of their data being compromised and the potential consequences, carefully weighing these risks against the benefits they receive in a completely new environment.

2.2. Social Factors (Social Interactivity and Social Presence)

The proficient operation of technology is contingent upon the possession of social aptitudes. As illustrated by (Cepero et al., 2024), consumers' social interactivity (SI) notably impacts the acceptability of innovative technologies. In this study, parameters including social language proficiency, emotional intelligence, compassion, and other pertinent dimensions are predominantly employed to evaluate the perceived SI of the MAPPs (Arpaci et al., 2022). According to Heerink et al. (2010), the social presence (SP) of the MAPPs is also closely related to the perception of how these applications interact with society. As reported by Schuetzler et al. (2020), the SP of a new technology will influence how consumers consider the technology. Research by (Kim et al., 2022) shows that advanced social skills play an active role in virtual environments where consumers need to abide by social rules. We believe these results indicate that consumers' attitudes toward MAPPs use are affected by their perceived SI and SP (Meyer-Waarden & Cloarec, 2022).

2.3. Motivational Factors (Social Recognition and Gamification)

External or extrinsic motivation includes factors that force characters to perform activities that target external rewards and consequences (Shin, 2009). These rewards can be tangible, such as economic rewards, prizes, or recognition, while social rewards include affirmation or recognition from others (Lai et al., 2023; Lee et al., 2019; Qian et al., 2023). On the contrary, we also define intrinsic motivation as participating in an activity that provides internal enjoyment or satisfaction without being influenced by external rewards (Hur & Baek, 2024). This can be traced back to the origin of inherent goals or values at the source (Baek & Kim, 2023; Wang et al., 2023). Similarly, social recognition (SR) refers to recognizing and acknowledging an individual's efforts and behaviors from their peers in a virtual environment (Jacobs, 2024). Consistent with previous theories, SR and GM have been proposed as incentive measures to enhance the adoption of MAPPs (Hong & Cho, 2023). On the other hand, GM promotes existing active participation and development through comprehensive game rendering such as incentives, challenges, and rewards (Gheorghe & Katina, 2023; Thomas et al., 2023). These factors are crucial for encouraging the

adoption of MAPPs, as they are expected to stimulate user motivation, satisfaction, and sense of achievement, as well as foster friendly relationships, community building, and identity formation in virtual environments.

2.4. Personality Factors (Openness and Locus of Control)

Personality is the totality of a person's dependably straightforward, predictable, and distinct psychological properties that are particular to an individual (Arpaci et al., 2022; Chuah et al., 2021; Ngcamu et al., 2023). For this purpose, the Big Five personality traits are a widely recognized paradigm that divides many aspects of human nature into five different factors: openness, extroversion, conscientiousness, neuroticism, and agreeableness (Costa Jr, 1992). However, the idea of openness (OP) (Costa Jr, 1992), and locus of control (LC) (Rotter (1954) only applied to personality traits in this study. Yuan et al. (2024) indicate that those with internal LC are more likely to adopt and use MAPPs actively. They tend to see technology as a spruce board to ignite their self-expression, personal growth, and opportunities to make independent choices (Yuan et al., 2024). Additionally, the more open they are to experience, the more they show ingenuity, novelty, uniqueness, and a boundless admiration of aesthetics (Wongkitrungrueng & Suprawan, 2023). In MAPPs, consumers are more disposed to interact with MAPPs when they believe in the impact of immersive experiences and the digital space according to their choice. They have the capacity for innovative thinking and are not restricted by traditional boundaries.

2.4. The Role of Configuration and Complexity Theories in the Adoption of MAPPs

Complexity theory is a field of research rooted in chaos theory. These complex structures exhibit nonlinear dynamics; therefore, the results depend on the interactions of different elements (Olya & Akhshik, 2019; Pappas & Woodside, 2021; Varnali, 2019). On the contrary, in configuration theory, consumers are identified by analyzing the structure or arrangement of enterprise elements (Rihoux & Ragin, 2008). This area of study more often focuses on how various structural components are arranged and how that arrangement affects the overall functionality and performance. Complexity and configurational theories are used widely across many fields, including strategic management, marketing, and information systems (Varnali, 2019). Using these theories, Zheng et al. (2024) explored the implications of metaverse applications by examining their adoption configurations within organizations. The study identified three different configurations that enhance decision-making and innovation performance. Liang et al. (2024) also

revealed five configurations that resulted in high user acceptance of the metaverse, with six configurations that led to low acceptance.

Similarly, the limitations of population-averaged approaches and traditional models can be circumvented by decomposing complex scenarios as a combination of related components (Foroughi et al., 2024; Tang & Yu, 2021). Therefore, rather than a relational element in the MAPP context, there is a need to examine the dynamic interaction of functional, social, motivational, and personality variables through their collective capabilities. The study of Yuan et al. (2024) also revealed the need for an enhanced framework using these complexity and configurational theories to combine different psychosocial dimensions related to metaverse adoption. Based on the integration of these theories, our proposed framework is intended to provide a full comprehension of the main research objectives and will enhance our understanding of the influences stemming from functional, social, and motivational factors, as well as individual personality traits that drive adoption. The application of this theoretical framework enhances the robustness of research and fosters the development of practical knowledge aimed at creating user-centric MAPP environments that meet diverse user needs and engagement.

2.4.1 Configurational Model

Configuration theory involves formulating propositions as causal recipes that cover different combinations and conceptually identify the factors that should be included or removed from the technique (Li & Larivière, 2023). In this study, the Metaverse adoption construct is considered dependent, and the four sets of causative dimensions are regarded as independent variables that predict the outcome. The intersections represent the amalgamation of factors and identify the areas where one component can potentially exist alongside the others. Figure 1 exhibits the effective use of a Venn diagram to accurately represent the complex influence of functional, social, motivational, and personality-related aspects on users' inclination to adopt MAPPs. The operational definitions of these constructions are specified in Table 1, along with corresponding references.

Key construct	Definition	Reference
Perceived Usefulness (PU)	The extent to which an individual holds the	(Davis, 1986; Shah,
	belief that implementing a specific system	Tang, et al., 2021)
	would improve their performance.	
Perceived Privacy (PP)	The hesitancy to continue using the	(Balapour et al., 2020;
	technology when perceiving a possible risk to	Huang et al., 2019)
	the security of their private information	

Table 1. Operational	definitions o	of the key	constructs
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Social Interactivity (SI)	The degree to which technology can simulate	(Fernandes & Oliveira,
	socially responsible sentiments toward human	2021)
	behaviors.	
Social Presence (PS)	The extent to which the consumer	(Heerink et al., 2010)
	acknowledges the technology products' actual existence.	
Social Recognition (SR)	The extent to which the adoption of a novel	(Meyer-Waarden &
	technology or product elevates an individual's	Cloarec, 2022;
	credibility within a specific group.	Venkatesh et al., 2012)
Gamification (GM)	The scientific and artistic transformation of	(Abou-Shouk &
	routine consumer interactions into business-	Soliman, 2021; Yang et
	oriented games.	al., 2017)
Locus of Control (LC)	The extent to which individuals perceive they	(Rotter, 1954)
	have authority throughout life activities, as	
	compared to outside influences.	
Openness to Experience (OE)	A person's inclination to investigate novel	(Shah et al., 2023)
	perspectives and participate in innovative	
	pursuits	

The relationship between PU and PP has an intricate interaction with adoption in the functional dimension of MAPPs, as shown by arrow A. Arrow B illustrates the complex influence of perceived SI on consumer's M-A within the social dimension. Similarly, arrow C indicates the motivational dimension, which encompasses SR and GM. An arrow D represents the intricate connection between customers' positive M-A and the factors of OE and LC in the dimension of users' personality-related factors. The ultimate intention to adopt, represented by arrow E, results from the causal connections among all preceding factors across the four dimensions. This configuration model serves as the methodological basis for developing hypotheses for this study.

Figure 1. Proposed Configurational Framework



PU (Perceived Usefulness); PS (Perceived Sacrifices); SI (Social Interactivity); SP (Social Presence); OE (Openness to Experience); LC (Locus of Control); GM (Gamification); Social Recognition (SR); M-A (Metaverse Adoption Intention)

2.4.2 Equifinality Principle

Adopting MAPPs and other associated technologies entails intricate interactions between their components, leading to diverse evaluations depending on the convergence of specific elements or conditions of the components (Loh et al., 2023; Shao, 2024). Generally, the relationships between variables and their intended outcomes may diverge. While it may not be sufficient to attain the desired result by itself, a variable may contribute to the plausibility of that result (Loh et al., 2023; Schmitt et al., 2017). Therefore, the intended result could be achieved through a multitude of possible combinations. Every individual arrangement of these components is commonly called a configuration (Pappas & Woodside, 2021). Drawing upon the equifinality principle, which posits the existence of complex interconnections among precursor events (Pappas, 2019), this article employs complexity theory to examine the configurations and antecedents of functional, social, motivational, and personality dimensions among consumers who adopt MAPPs. As a result, the subsequent hypothesis is proposed:

H1: Multiple configurations of causal factors are equivalently effective in creating high adoption, as is a single optimal combination of personality, social, motivational, and functional factors.

2.4.3. Asymmetric and Nonlinearity Principal

A second major idea in complexity theory is causal asymmetry. Greckhamer et al. (2018) explored that the reliability of symmetrical and solitary causation relationships is threatened by causal asymmetry. This suggests that the effect of a particular causal element on the desired result may vary based on its interaction with other such causes (Ali et al., 2023; Shao, 2024). Therefore, configurations that provide favorable outcomes do not accurately mirror configurations that generate undesirable results (Farmaki et al., 2021; Zhu et al., 2022). For example, the extent consumers are inclined to use MAPPs depends on how well these applications are integrated with other factors, such as functional, social, motivational, and personality. Thus, it is suggested that: *H2: The adoption of consumers' MAPPs could be influenced by distinct causative factors, which*

can vary based on their interaction with other factors.

Furthermore, various arrangements of M-A can include a mixture of functional, social, and personality characteristics. MAPPs adoption replicates human actions and the surrounding environment using technical advancements and social characteristics (Shao, 2024). Wongkitrungrueng and Suprawan (2023) found that consumer responses to MAPPs can vary depending on individual personality factors. Therefore, consumers evaluate the extent to which the characteristics of the application align with their traits. The above rationale led to the development of the subsequent hypothesis:

H3: Advanced M-A configurations necessitate the concurrent presence of functional, social, motivational, and personality dimensions.

fsQCA, as a comprehensive research tool, has recently gained significant popularity in scholarly research. This method, which employs Boolean logic to identify conjunctural causations leading to an outcome, provides valuable insights when investigating complex phenomena (Schmitt et al., 2017; Shah et al., 2023; Shao, 2024). Existing literature primarily employs statistical approaches that focus solely on the net effect of individual variables. Recently, these methods have been criticized for causing issues such as multicollinearity and for assuming symmetric relationships. Further, the relationships between antecedents and outcomes in social science are often asymmetric, highlighting the need to use fsQCA in capturing these complexities (Pappas & Woodside, 2021; XinYing et al., 2024). Since fsQCA can capture the complex interrelationships by providing a case-based investigation grounded in causal complexity theory, this study fills a gap in prior literature by exploring how various psychosocial factors influence the adoption of MAPPs through the lens of configuration and complexity theories.

3. Research Methodology

3.1. Data Sample and Measures

The Metaverse has piqued the interest of Chinese consumers, specifically 78%, indicating a strong desire to participate in Metaverse games and other MAPPs (Interesse, 2022). In comparison, these numbers are much higher than 57% in the US and 47% in the UK (Interesse, 2022). The Chinese government is also paying close attention to the virtual technology business, which is of great interest and has attracted a lot of attention recently (Tlili et al., 2023). The three-year action plan for the Metaverse development industry (2023–2025) aims to position the Metaverse as a catalyst for inventive growth by fostering creativity and advancement (Chen et al., 2024). Therefore, China becomes an ideal research context for this study to obtain the desired sample size.

This study employed a quantitative survey approach of twenty-eight items, each evaluated on a five-point Likert scale, using a questionnaire derived from existing literature (Ali et al., 2016; Shah et al., 2024). The questionnaire was developed in English and subsequently back-translated into Mandarin Chinese with the assistance of three native experts in the field of management. We specifically evaluated and revised the phrasing of items to correspond with the distinctive characteristics of the Metaverse environment. The items phrases were customized to represent user experiences and interactions in immersive environments using MAPPs. Before seeking the expert's opinions, dialogue clarification is employed to comprehend both their explicit and implicit meanings. We guaranteed that the redesigned questions preserved their initial theoretical significance while augmenting their pertinence to the research's context. Next, a group of seven experts was provided with a comprehensive summary of the formulated measurement scales for review and appraisal. The input from experts significantly improved the clarity of the survey instrument.

The revised survey was then pilot-tested with a random sample of 30 consumers, of whom 23 satisfactorily filled out and submitted the questionnaire. A two-step procedure (Abunyewah et al., 2020; Fatemi et al., 2021) is then followed to assess the reliability and validity of the measurement scale. The size of the selected sample is within the recommended range of 10 to 30 Isaac and Michael (1995). The constructs exhibited acceptable reliability in a pilot study, with a coefficient alpha (α) of at least 0.7. Additionally, the finding of the statistical significance of the results surpasses the threshold of 0.5, confirming their validity.

Next, the study used a cross-sectional research design to gather data from the most relevant respondents. The unit of analysis in this study was individual responses obtained by purposive snowball sampling approaches, so the possible presence of common method bias cannot be disregarded (Podsakoff et al., 2003; Wirtz et al., 2014). Purposive sampling guarantees the inclusion of people with particular knowledge or traits pertinent to the research, while snowball sampling is advantageous for reaching elusive groups (Azhar et al., 2024). Collectively, these methodologies are essential for gathering comprehensive targeted data samples. Further, we used specific priori remedies and one post-hoc procedural remedy to alleviate this risk and address common method bias (Podsakoff et al., 2003). First, we ensured that respondents represented various functional roles inside MAPPs at various levels, allowing us to get a range of perspectives from each participant. Secondly, we conducted statistical tests (i.e., chi-square difference test ($\Delta \chi 2$)) to ascertain that repeated responses did not unduly influence the study or introduce bias. Ultimately, the variance inflation factor (VIF) collinearity analysis validated that common method bias does not pose an issue in this research, as all values remained within the 3.3 threshold value (Podsakoff et al., 2003).

A total of 390 completed questionnaires were collected from January 15, 2024, to April 25, 2024. However, 18 were deleted as there was insufficient information, and 372 were left as valid replies. The discriminant validity, factor loading, composite reliability (CR), Cronbach's alpha (C- α), and average variance extracted (AVE) were first assessed, and NCA analysis was conducted using SmartPLS 4.0 before the fsQCA analysis. Integrating PLS-SEM, NCA, and fsQCA analytical techniques enables researchers to surmount individual methodological constraints and provide a deeper understanding of the major factors and their interrelations. For example, Richter et al. (2020) illustrated the excellent integration of PLS-SEM and NCA to delineate essential components and necessary conditions, hence enhancing our comprehension of the impacts of particular constructs. Vis and Dul (2018) integrated NCA and fsQCA to ascertain the essential circumstances and adequate configurations for an inevitable conclusion, illustrating how data variances may enhance the overall analytical quality. Consequently, this methodological framework enhances value by efficiently using data, expanding the researcher's comprehension, and augmenting explanatory power (Rasoolimanesh et al., 2021).

3.2. fsQCA Analysis

In fsQCA, the first step involves explicitly defining the outcome and the independent variables. The next stage consists of converting all measurements into sets of fuzzy integers, where the values range from 0 to 1, representing their level of membership in a specific group. The calibration of data can be done either directly or indirectly. However, the most basic method uses the maximum, average, and minimum values. This study utilized a 5-point Likert scale to establish the qualitative limits of full-non/full-membership, with a cutoff point. Ragin (2009) defines a fuzzy membership score of 1 as indicating complete membership, a score of 0 as indicating non-full membership, and a value of 0.5 as representing an intermediate level of membership. Consequently, three thresholds of 0.95, 0.5, and 0.05 can be employed. The number of significant results may be reduced by calibrating the survey scale, resulting in only one solution that satisfies all the necessary conditions (Pappas & Woodside, 2021; Schmitt et al., 2017).

Next, the truth table is developed, displaying various combinations of cases by including every possible configuration of causative conditions. The configurations for binary data variables are represented by K*2, where K is the total of the independent variables. To narrow down the range of feasible configurations, defining the "frequency cut" parameters and excluding uncommon configurations is necessary. The truth table was organized using frequency and consistency criteria (Pappas, 2019; Schmitt et al., 2017). The Quine-McCluskey algorithm was employed to generate three solutions: intermediate, economical, and complex (Shah et al., 2023; Woodside, 2021). Among these, the intermediate solution was deemed more favorable due to its mere simplification of propositions (Pappas & Woodside, 2021). In conclusion, the fsQCA provides intricate and succinct information regardless of the simplifying assumptions made by the scholar, while the intermediate response directly depends on those assumptions. As a result, the intermediate solution was chosen for configuration analysis in this study. A black circle is frequently used to indicate the presence of a condition, a crossed-out circle denotes its absence, and a vacant area signifies a "do not care" state (Shah et al., 2023). Additionally, the researcher must exhibit the comprehensiveness and uniformity of the solution.

4. Research Results

4.1. Demographics Profile of the Sample

Regarding demographic details, the male cohort comprised 59% of the total participants, while the female populace comprised 40% regarding gender distribution. Many (36%) were aged between

18 and 40 and possessed a bachelor's degree, while 46% held a master's degree or higher. The data indicates that 34% of the participants utilized alternative technological applications, while 65% utilized the MAPPs in various capacities.

4.2. Validity and Reliability Analysis

The study analyzed external loading values to establish the relationship between reflective indicators and latent factors. Most users reported contentment with the items of MAPPs, as indicated by the mean value ranging from 3.27 to 4.02 on a five-point scale, as shown in Table 2. The range of standard deviations (0.711 to 0.977) and VIF (1.07-2.87) indicated that the data fell within an acceptable range (Shah, Zhongjun, et al., 2021). Using the PLS-SEM measurement approach, the factor loadings (0.668 to 0.912) for all causative situations surpassed the thresholds of 0.5-0.7. The values of composite reliability (CR), Cronbach's alpha (C- α), and average variance extracted (AVE) were within the acceptable range of 0.5. These values demonstrate that convergent validity has been successfully established (Shah & Zhongjun, 2021; Sharif et al., 2022). The HTMT ratio was used to evaluate the discriminant validity. The HTMT values for this experiment were all below 0.85, indicating that discriminant validity was achieved. This is demonstrated in Table 3. Every component in the model complies with this condition, as no element outside the diagonal surpasses the equivalent diagonal element (Hair Jr et al., 2016). The structural model results in Table 4 also confirmed the individual factors' significant impact ($p \le 0.05$) on MAAPs adoption.

Items	VIF	Mean	SD	Factor loading
GM1	1.979	3.669	0.948	0.870
GM2	2.105	3.515	0.977	0.873
GM3	2.113	3.661	0.861	0.886
LC1	1.546	3.741	0.906	0.864
LC2	1.195	3.653	0.795	0.684
LC3	1.495	3.787	0.916	0.798
M-A1	2.003	3.928	0.815	0.844
M-A2	2.052	3.589	0.887	0.848
M-A3	2.134	3.715	0.910	0.865
M-A4	1.487	3.803	0.825	0.727
OE1	2.583	3.528	0.920	0.902
OE2	1.357	3.651	0.899	0.726

Table 2. Items basic statistics and factor loading values

OE3	2.659	3.632	0.899	0.912
PP1	1.378	4.029	0.818	0.759
PP2	1.867	3.581	0.893	0.895
PP3	1.560	3.275	0.986	0.782
PU1	1.139	3.821	0.872	0.703
PU2	2.827	3.859	0.755	0.858
PU3	2.887	3.811	0.779	0.872
SI2	2.445	3.856	0.852	0.908
SI2	1.320	3.701	0.735	0.705
SI3	2.309	3.768	0.859	0.892
SP1	1.077	3.795	0.768	0.668
SP2	2.283	3.957	0.711	0.843
SP3	2.215	3.965	0.742	0.817
SR1	1.760	3.715	0.910	0.875
SR2	1.890	3.779	0.916	0.850
SR3	1.548	3.821	0.872	0.799

Table 3. Constructs validity and reliability and discriminant validity

Items	C-α	CR	AVE	GM	LC	M-A	OE	PP	PU	SI	SP	SR
GM	0.849	0.908	0.768	0.856								
LC	0.687	0.827	0.617	0.774	0.785							
M-A	0.840	0.893	0.677	0.887	0.819	0.823						
OE	0.806	0.886	0.724	0.822	0.814	0.830	0.851					
PP	0.744	0.854	0.662	0.843	0.740	0.817	0.784	0.814				
PU	0.740	0.854	0.663	0.697	0.646	0.782	0.645	0.620	0.814			
SI	0.788	0.877	0.706	0.856	0.797	0.880	0.796	0.771	0.740	0.840		
SP	0.671	0.822	0.608	0.639	0.667	0.727	0.617	0.605	0.735	0.750	0.780	
SR	0.796	0.880	0.709	0.823	0.775	0.880	0.779	0.766	0.734	0.806	0.637	0.842

Similarly, the NCA method is utilized to ascertain whether a condition is essential and quantitatively measure the degree to which the cause functions as a bottleneck for the outcome, thereby identifying necessary conditions (Dul, 2016). The NCA serves as a valuable addition to fsQCA, mainly offering notable benefits analyzing necessary conditions. Vis and Dul (2018) recommend that if the effect size of the antecedent condition is not less than 0.1, p < 0.05, and the

accuracy exceeds 95%, the cause can be identified as a necessary condition for the outcome. The significant relationship for each independent variable has been plotted in Figure 2 of the NCA analysis. In accordance with the procedures established by (Richter et al., 2020) and (Sukhov et al., 2022), we analyzed the effect values for all dependent variables to assess the significance of the data utilizing SmartPLS. All the effect sizes were moderate and above 0.03, as shown in Table 4.

PLS-SEM				NCA		
	Original			Permutation p		
	sample	t-statistics	P values	effect size	95.00%	value
$GM \rightarrow M-A$	0.228	5.032	0.000	0.368	0.092	0.00
LC→M-A	0.078	2.034	0.043	0.440	0.123	0.00
$OE \rightarrow M-A$	0.077	2.209	0.028	0.374	0.107	0.00
PP →M-A	0.073	2.057	0.041	0.351	0.106	0.00
PU→M-A	0.127	3.158	0.002	0.198	0.053	0.00
$SI \rightarrow M-A$	0.157	3.480	0.001	0.362	0.091	0.00
SP→M-A	0.064	2.150	0.033	0.202	0.067	0.00
$SR \rightarrow M-A$	0.255	7.383	0.000	0.378	0.103	0.00

Table 4. Structural model direct effect, NCA accuracy, effect size, and p-value



Figure 2. NCA plots of independent factors

Finally, this study validates the applicability of complexity theory concepts to adopting MAPPs and highlights the inherent complexities in the adoption process. The fsQCA analysis identified seven distinct configuration patterns (as shown in Table 5) associated with a high intention to use MAPPs. The solution's total consistency was 0.97, indicating a high confidence level in the outcome's causal relationship. Based on the results, the inclusive solution coverage was 0.89, signifying that 89% of individuals with a high-level intention to utilize MAPPs demonstrated these seven causal situational arrangements.

S. No.	PU	PP	SP	SI	SR	GM	LC	OE	Raw Coverage	Unique Coverage	Consistency	Overall solution coverage	Overall solution consistency
1.		0						0	0.846	0.039	0.994	0.893	0.978
2.	0	ullet	ullet	ullet	lacksquare	0	ullet	ullet	0.818	0.014	0.992		
3.	lacksquare	\otimes	ullet	ullet	lacksquare	0	\bullet	\otimes	0.328	0.0025	0.999		
4.	ullet	ullet	ullet	0	\bullet	\otimes	ullet	ullet	0.365	0.001	0.997		
5.	ullet	ullet	lacksquare	ullet	\bullet	ullet	0	•	0.805	0.008	0.996		
6.	ullet	ullet	ullet	ullet	0	ullet	ullet	ullet	0.805	0.008	0.996		
7.	ullet	ullet	lacksquare	\otimes	\otimes	ullet	\otimes	\otimes	0.259	0.001	0.998		
Present	ce —			Abs	sence			0	Don't Ca	re	▶ ⊗		

Table 5. fsQCA path analysis, consistency, and coverage

The results indicate that a single factor cannot adequately or exclusively predict adoption intentions. The fsQCA analysis yields results that corroborate all three scenarios. To begin with, a multitude of configurations or causal patterns have been recognized as indicators of elevated M-A, thereby implying the existence of equifinality (Proposition 1). Additionally, the results suggest the presence of causal asymmetry, which means that high M-A may result from the presence or absence of identical causal elements, depending on how they interact with other causal factors in different congruences (Proposition 2). Moreover, proposition 3 asserts that functional, social, and personality dimensions coexist concurrently in all four configurations.

5. Discussion

Our analysis explored seven novel configurations using a novel methodology of PLS-SEM, NCA, and fsQCA, which combines complexity theory and configurational assessment to investigate the phenomenon of MAPPs adoption from a new angle. The first configuration points out that PU is rooted in users' realization that the platform can help improve many parts of their lives, prompting them to start interacting with it (Ashfaq et al., 2020). At the same time, the absence of PP tells us that users do not care about the privacy imperatives associated with their virtual encounters (Prakash & Das, 2021), indicating that the benefits of MAPPs outweigh any possible privacy threat, so it propagates its use. Regarding socially interactive aspects such as SI and SP, the first configuration is similar to the output of studies such as (Hossain, 2016; Kim & Oh, 2022). This complicated interaction also includes SR and GM factors, which encourage users to actively participate and support online communities to get recognition and get involved (Thomas et al., 2023). In the study of Zhou et al. (2024), LC suggests that users have a sense of autonomy and control in virtual interactions in MAPPs. Moreover, if users have not been exposed to OE, this may involve that they are less willing to construct novel and unknown virtual environment (Shah et al., 2023).

The possible reason for the lack of PU in the second configuration is that users may not be able to actually use many MAPPs because they may lack knowledge or be unfamiliar with their working principles (Al-Adwan et al., 2023). Later, users' concern for privacy and confidentiality indicated that they had perceived the anonymity of personal information and privacy in virtual environments. While incorporating SR with SI and SP, meta social networks can elevate user engagement, recognition, and effectiveness (Wang et al., 2023). Moreover, if users have not been exposed to OE, they may be less willing to construct a novel and unknown virtual environment

In the third configuration, the availability of PU and consumers' lack of enthusiasm for PP are important, as consumers also prioritize SI, SP, and SR in MAPPs. This is because advanced technology applications in China are often seen as tools to improve social efficiency, and users' broad understanding of technology and strong trust in government regulations help reduce concerns about privacy (Husairi & Rossi, 2024; Wong et al., 2015). However, the absence of GM components suggests that users are motivated by internal factors rather than external rewards or incentives, as they seek fulfillment and happiness through virtual relationships and experiences (Cha et al., 2024). Moreover, LC and OE indicate that users feel empowered when navigating and

manipulating virtual experiences. They see themselves as proactive participants in the digital environment, motivated by practical advantages and personal independence rather than mere curiosity or uniqueness. This sense of empowerment influences their decision to adopt the MAPPs.

The presence of PU and PP in four distinct configurations suggests that users have a conscious understanding of the data and privacy concerns associated with MAPPs (Wang et al., 2023). However, they believe that the benefits outweigh the potential privacy risks, which encourages its widespread adoption. In the absence of SI in the Metaverse, consumers value SP and SR as they desire to establish deeper connections and get peer validation even in low direct interaction (Wang et al., 2023). This configuration has the same minimum focus on GM as the last one, additions of which include OE and LC signifying recognition of PU, coupled with PP, SP, and inherent drive. Furthermore, it embodies a sense of autonomy and a desire to accept innovative experiences, much as Chinese consumers are increasingly accustomed to advanced technical applications. The fifth configuration is similar to the first one but includes a PP element. Users demonstrate awareness of their data and privacy concerns within the MAPPs, indicating they believe their privacy is sufficiently protected (Zhao et al., 2023). Similarly, OE implies that individuals are receptive to adopting innovative technologies and online platforms, fostering curiosity and a willingness to experiment with unfamiliar concepts. Consequently, this mindset promotes the effective adoption and use of Metaverse technology.

Moreover, the absence of SR in the sixth configuration indicates that users' primary source of motivation for executives does not come from external peer validation or verification. The Metaverse doesn't reward intrinsic satisfaction and fulfillment. Users in the final configuration prioritize SP in the MAPPs over SI, demonstrating a preference for feeling fully immersed and having a solid sense of presence in virtual worlds. Similarly, the absence of focus on social validation and recognition suggests that users prioritize internal happiness and enjoyment in the Metaverse rather than seeking external validation or acceptance from their peers. Moreover, the insufficient focus on LC implies that users may not recognize a substantial need to control their virtual experiences actively; however, they are still willing to engage in the Metaverse.

Our results provide robust support for configuration theory, finding no singular component that dominates but rather that different mixtures of functional, social, motivational and personality factors do. The results fit with the tenets of complexity theory and show that MAPPs are non-

linear, vibrant, and spontaneous. Hence, complexity theory allows us to encompass all of this and the complicated, adaptive characteristics of behavior.

5.1. Theoretical Implications

The findings of this study contribute to Metaverse literature in two vital ways. First, this study is firmly grounded in theory, unlike much of the existing literature, which has often overlooked robust theoretical frameworks. It integrates configurational and complexity theories within the MAPPs context to systematically examine the factors influencing adoption. By incorporating complexity theory, we seek to deepen the understanding of overarching patterns in MAPPs adoption, while configuration theory aids in identifying specific configurations or patterns within this intricate framework (Xie & Tsai, 2021).

Second, whereas existing literature on factors influencing Metaverse adoption from the user perspective has primarily utilized structural equation models (e.g., (Al-Adwan et al., 2023)) or experimental research methods (e.g., (Xi et al., 2024)) to assess the effects of each factor in isolation, we advance the use of experimental design paired with surveys to examine multiple factors simultaneously. We must recognize that a monolithic methodology is unlikely to adequately address the pluralities that are intrinsically an inherent and standing part of the quantitative social sciences (Liu & Meng, 2024).

This study advances the methodological progress of Metaverse literature by using PLS-SEM, NCA, and fsQCA techniques, thereby deepening our understanding of the complex interactions of factors influencing Metaverse adoption (e.g., (Irfan et al., 2024; Wang et al., 2023; Yuan et al., 2024). We conducted a necessity analysis to determine the conditions users need to adopt MAPPs (Richter et al., 2020). The research results of NCA indicate that stimulating MAPPs behavior requires more than a single antecedent. Finally, the configuration discovered in this study revealed four psychosocial factors that influence the adoption of MAPPs: functional, social, personality, and motivational traits. Some of the previous studies (e.g., (Arpaci et al., 2022; Ball, 2022; Wang et al., 2023) have also focused on these factors; however, they have not examined the interplay of each antecedent and its distinct influence on adoption behavior. The findings of our study indicate that it is essential to address the complex effects arising from the interaction of multiple antecedents, even though the impact of any single variable may be minimal.

The present study provides empirical support and contributes to the theoretical framework by providing additional insights from functional, social, motivational and personality dimensions. The configuration results from this study initially offer a basis for further investigation and refinement of the frameworks outlined before, resulting in a more refined understanding of user behavior and adoption dynamics in the Metaverse context.

5.2. Practical Implications

Given the Metaverse industry's significant expansion, this study presents many configurations that managers and policymakers can deploy to enhance consumer interaction and MAPPs adoption (Waqar et al., 2023). These seven outcomes of the configuration analysis serve as a point of reference for the technological design, planning, and evaluation of potential functional, social, and personality variables of the MAPPs. Developers can develop various interactive and customized tools under multiple aspects such as virtual events and places of co-working spaces that emphasize the preferences of the user in collaborative activity (Higgins et al., 2022). For instance, virtual showrooms will facilitate the use of 3D product models with virtual clothes try-ons or home furnishings previews for retail and e-commerce enterprises. Similarly, virtual shopping assistants can offer customized product recommendations to enhance consumers' perception of usefulness. Therefore, with these progressive consultants, managers and policymakers can learn about product positioning by overseeing applications.

Moreover, this study demonstrates how MAPPs effectively circumvent peculiar functions such as risk management, recurrence, and sustainability through humanizing, approaching, and trusting the philosophy of the virtual image and emphasizing the virtual image's societal context. This focus is critical to increasing consumer comfort and satisfaction with routine services (Nadarzynski et al., 2019). Regarding PP concerns, MAPPs makers may not benefit from adopting a standard strategy that caters to all consumers. Individuals with high OE and LC scores but a low level of worry about PP, SI, and SP may have their data utilized to develop individualized services. However, to address end users' concerns about privacy and social issues, it is advised that MAPPs organizational leadership create more strict regulations targeted at protecting personal data and supporting the transparent and socially responsible use of MAPPs.

The findings of this study indicate that designers and developers should incorporate additional features and services that prioritize social, motivational, and personality aspects rather than focusing solely on functionality. Attracting users who are not currently engaged with MAPPs could serve as a method to promote and potentially enhance active engagement among users. Therefore, developers should integrate techniques like gamification, dynamic social settings, and

AI-driven customization to promote positive engagement and facilitate significant interactions. For example, the entertainment and gaming industries need to create virtual musical venues in conjunction with social interaction platforms that facilitate user engagement and connectionbuilding. Similarly, the use of haptic feedback, lifelike avatars and NFT-supported virtual assets to enhance immersion and facilitate SP and SR mechanisms.

Finally, firms engaged in the development and promotion of MAPPs must use strategies that enhance consumer satisfaction, evoke positive emotions, and mitigate the occurrence of adverse behaviors, as informed by Zillmann (1988) through mood management theory. For this purpose, developers can create visually captivating environments and interactive components that immerse users in imaginative worlds and different dimensions. Design virtual travel experiences that enable consumers to explore locations, hotels, or cultural attractions prior to making reservations in tourism and hospitality. Similarly, considering the importance of social and personality elements in various cultures, we believe that text mining of consumer opinions and evaluations, together with collaborative filtering or pattern analysis of consumer ratings are two technical approaches that can be used to collect insights on social and personality values. Therefore, employing configurational analysis to customize experiences for various user categories and consistently modify offers depending on real-time feedback.

6. Conclusion

The existing Metaverse literature primarily utilizes symmetric variance-based methodologies to investigate the determinants of adoption, focusing on the analysis of each factor in isolation. As a result, these studies have not thoroughly accounted for the extensive influence of the interactions among these factors. Following the rapid growth of MAPPs, it is essential to comprehend how various psychosocial factors and their arrangements influence MAPPs adoption. From the perspectives of configuration and complexity theories, this study's results identified seven different solutions, each characterized by a unique combination of personality, motivational, social, and functional characteristics. This research contributes to the Metaverse literature by providing a comprehensive theoretical framework based on configuration and complexity theories to elucidate the asymmetric influence of psychosocial variables on MAPPs adoption. This research enhances scholarly understanding using a novel approach that utilizes PLS-SEM, NCA, and fsQCA, as well as a constructive analysis that provides management insights to investigate various factors impacting Metaverse adoption. Finally, by leveraging insights into user preferences, motives, and

social interactions, Metaverse developers and industry practitioners can create engaging and interactive MAPPs tailored to the specific needs and interests of consumers.

6.1. Limitations and Future Research

Like any research, this study is exposed to some limitations. First, this study relies solely on selfreported data from a survey and does not account for the usage environment. However, understanding the context in which new technology is adopted is essential for thoroughly analyzing the factors influencing technology adoption. Therefore, future studies could integrate multiple data sources, including semi-structured interviews, observations, and data obtained from real-world usage. Second, this research focused on a particular region by focusing only on Chinese consumers. It is particularly important to assess the relevance of the results across various cultural environments as cultural disparities will profoundly influence the psychological aspects of technology adoption. Consequently, further research should empirically evaluate the suggested framework and hypotheses across different countries or territories to thoroughly comprehend the influence of cultural variations on MAPP adoption. Finally, our study used self-reported data that are usually susceptible to perceptual and cognitive biases, thereby compromising the accuracy of results. To enhance internal validity and determine causal relationships, additional studies should employ longitudinal research to observe user behavior and adoption patterns over time. Furthermore, experimental methodologies such as virtual environment simulations and the integration of mixed-methods research, which combines user interviews with behavioral analytics, can assist in isolating the impact of specific factors on adoption. These techniques will alleviate current limitations and offer valuable insights for improving Metaverse adoption strategies.

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