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Lights, Camera, Metaverse!

Eliciting Intention to Use Industrial Metaverse, Organizational Agility, and Firm Performance

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ABSTRACT

This study investigates organizations' intention to use the industrial metaverse. The unified theory of acceptance and use of technology (UTAUT) is used as an underpinning theory to examine the impact of performance expectancy, effort expectancy, social influence, and facilitation condition on the intention to use the industrial metaverse. The results of this study reveal that performance expectancy, social influence, and facilitating conditions significantly influence the intention to use the industrial metaverse. Moreover, the intention to use the industrial metaverse significantly influences organizational agility and firm performance. Further, the results of moderation hypotheses indicate that the impact of both performance expectancy and social influence on intention to use the industrial metaverse varies at high and low levels of firm innovativeness. The study's findings will enrich the metaverse literature. Further, it provides a deeper understanding of industrial metaverse adoption from a B2B perspective using the underpinnings of UTAUT. The study helps organizations understand the enablers of industrial metaverse usage intention.

KEYWORDS

Enterprise Metaverse, Firm Performance, Industrial Metaverse, Organizational Agility, UTAUT

1. INTRODUCTION

Recent technology developments have undeniably had a profound impact on the way individuals think and behave (Kumar & Shankar, 2023). Consumers have become more receptive to adopting new technologies (Shankar et al., 2023; Kumari & Kumar, 2023). Consumers today are generally more comfortable and familiar with technology than in the past (Lashitew, 2023). One of the biggest

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reasons for the same is the increasing internet and digital device penetration that has created a tech-savvy consumer base (Srivastava et al., 2023). Consumers increasingly expect personalized experiences from emerging technologies (Flavián et al., 2019). They seek products and services that cater to their unique preferences and lifestyles (Tom Dieck & Han, 2022). Therefore, emerging technologies such as artificial intelligence (AI), machine learning, big data analytics, virtual reality, augmented reality, and mixed reality enable companies to gather and analyze consumer data to deliver personalized recommendations that offer consumers immersive and interactive experiences (Ameen et al., 2021; Chylinski et al., 2020; Flavián et al., 2019; Holmlund et al., 2020). One such upcoming immersive technology is the metaverse. The metaverse has gained recognition as the upcoming era of social interactions, offering a unique environment where individuals can "exist" within the framework established by its creator (Hwang & Chien, 2022). This concept encompasses a world that can be entirely or partially virtual (Avila, 2017). It could take the form of a fully immersive virtual reality system or incorporate augmented reality elements within real-world settings (Kozinets, 2022). Within the metaverse, people have the opportunity to participate in a range of social activities (Allam et al., 2022). However, several reports suggest that the metaverse's real potential and use cases lie in the industrial setting (B2B) rather than the consumer setting (B2C) (Financial Times, 2023). The industrial version of the metaverse is the industrial or enterprise metaverse. The industrial or enterprise metaverse is a technologically advanced virtual ecosystem tailored for industrial applications by merging data, AI, and digital representations of physical assets and processes (Kshetri, 2023; McKinsey & Company, 2022a).

According to ABI Research, the industrial metaverse market is set to reach a significant size of $100 billion by 2030. This figure surpasses the combined market value of both the consumer metaverse ($50 billion) and the enterprise metaverse ($30 billion) (VentureBeat, 2022). Moreover, other projections indicate an even more significant economic impact, with Microsoft's COO, Judson Althoff, stating that the industrial metaverse's market opportunity could exceed $200 billion by 2030 (SdxCentral, 2022). Lastly, a survey conducted by McKinsey & Company (2022b) revealed that about 57% of the organizations aware of metaverse say they will adopt the technology in the near future. The above statistics clearly reveal the positive intent the organizations are keeping towards the industrial metaverse.

Despite the growing interest in the concept of the industrial metaverse and its potential impact in the B2B context, there remains a notable literature gap in research specifically focused on the adoption of the metaverse in businesses and its influence on organizational agility and firm performance. One prominent research gap pertains to the lack of comprehensive studies that delve into the specific factors influencing the adoption of the industrial metaverse across diverse sectors. Furthermore, exploring user experiences and perceptions of the industrial metaverse remains relatively unexplored. While some studies have explored the adoption of social media (Ahmad et al., 2019), business intelligence systems (Popovič et al., 2019), AI-CRM (Chatterjee et al., 2022), retail 4.0 (Sakrabani & Teoh, 2021) and e-procurement systems (Chang & Wong, 2010) in isolation, there is a scarcity of comprehensive research that systematically investigates the metaverse's integration in the organization and its subsequent effects on organizational outcomes. Moreover, the intention to use the industrial metaverse may enable the firms to quickly detect and respond to opportunities and threats, which acts as a critical antecedent to organizational agility. Therefore, agile organizations can effectively align and integrate digital capabilities to embrace metaverse technologies and enhance their overall performance (Ciampi et al., 2022). For instance, a report reveals that enterprises that have implemented industrial metaverse applications are witnessing significant advantages in terms of curbing capital expenditures (15%), enhancing sustainability (10%), and elevating safety standards (9%) in comparison to their competitors (ET Telecom, 2023).

Therefore, the authors believe that it is a timely effort to examine how the industrial metaverse can enhance firm performance using the underpinnings of UTAUT. Further, this research also attempts to understand the adoption intention towards the industrial metaverse in the business-to-business

(B2B) context. The above arguments highlight a significant literature gap. Therefore, this research answers the following research questions:

RQ1. What factors are responsible for the intention to use the industrial metaverse?
RQ2. How does the intention to use the industrial metaverse influence firm performance?
RQ3. Does firm innovativeness play a critical role in the intention to use the industrial metaverse?
RQ4. What are the most important variables responsible for the intention to use the industrial metaverse?

The study offers several theoretical and practical implications. Theoretically, the study enriches the industrial or enterprise metaverse literature. The study examines the influence of metaverse adoption on organizational agility and firm performance, thereby contributing to the agility and firm performance literature. The study also contributes to the literature pertaining to the UTAUT framework. Practically, this study provides a roadmap to the organizations for inducing the metaverse technology into their organizational setup. Also, the study will be helpful for top leadership managers in understanding what are the crucial variables that may influence the acceptance towards industrial metaverse technology. The remainder of the article is organized as follows. Section 2 highlights the underpinnings theory, followed by a literature review and hypotheses development in Section 3. Sections 4–5 focus on methodology and results. Further, Section 6 and 7 highlights the discussion and implication section. Finally, Section 8 elaborates on limitations and future research directions.

2. UNDERPINNING THEORY

UTAUT is a comprehensive framework in the field of technology adoption (Venkatesh et al., 2003). Developed by Venkatesh et al. (2003), the UTAUT synthesizes and extends existing technology acceptance theories, such as the Technology Acceptance Model (Davis, 1986), the Theory of Reasoned Action (Fishbein, 1979), and the Theory of Planned Behavior (Ajzen, 1991). The UTAUT framework aims to explain and predict individuals' intentions to use a particular technology (Chatterjee et al., 2021). The UTAUT framework comprises four critical antecedents of technology adoption: performance expectancy, effort expectancy, social influence, and facilitating conditions, which collectively influence users' behavioural intentions and actual technology usage (Venkatesh et al., 2003). UTAUT has been used to investigate behavioural intentions towards upcoming technologies in various contexts, such as e-learning systems (Abbad, 2021), mobile payments (Al-Saedi et al., 2020), virtual reality (Huang, 2023), e-health (Arfi et al., 2021), AI-CRM systems (Chatterjee et al., 2021), wearable devices (Wang et al., 2020), mobile banking (Jadil et al., 2021), and electric vehicles adoption (Jain et al., 2022). Therefore, this study also adopts the UTAUT framework to examine the behavioural intentions towards the industrial metaverse (see figure 1), as UTAUT has successfully provided consistent results with context to other emerging technologies.

3. LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

3.1. Industrial Metaverse

The concept of the industrial metaverse pertains to a sector within the metaverse framework that emulates and replicates real-world machinery, factories, urban areas, transportation systems, and intricate systems (Kshetri, 2023). This segment will provide participants with completely engrossing, up-to-the-moment, interactive, continuous, and synchronized portrayals and simulations of the actual world (MIT Technology Review, 2023). This novel realm will be constructed using existing and evolving technologies such as digital twins, artificial intelligence, machine learning, extended reality, blockchain, as well as cloud and edge computing (Wang & Zhao, 2022). These components will amalgamate to establish a robust interface that bridges the gap between the physical and the digital realm, resulting in an outcome surpassing its individual constituents' collective impact (Bhattacharya et al., 2023). The industrial metaverse is poised to transform conventional work methodologies while concurrently introducing substantial novel value to businesses and societies at large (Ricci et al., 2023). However, despite the potential industrial metaverse holds, there have been very few attempts in the literature to examine the phenomenon. Further, as per the author's knowledge, this study is one of the pioneers in empirically understanding organizational sentiments towards the industrial metaverse. Therefore, the authors believe that understanding the organizational perspective towards the industrial metaverse using the UTAUT framework (performance expectancy, effort expectancy, social influence and facilitating conditions) enriches the literature as no study, as per the author's knowledge, examined the behavioural outcomes towards the industrial metaverse.

3.2. Hypotheses Development

3.2.1. Performance Expectancy

Performance expectancy refers to the user's belief and perception regarding the extent to which adopting and using a particular technology will enhance their overall performance and productivity (Tamilmani et al., 2021; Venkatesh et al., 2003). The literature suggests that performance expectancy significantly affects organizational behaviour and their decision-making processes (Chaudhary & Suri, 2018). Positive perceptions about the technology's potential benefits drive the organization's willingness to explore and invest in its implementation (Arpaci et al., 2022; Kwateng et al., 2018). For instance, Arpaci et al. (2022) revealed that performance expectancy has a positive influence on behavioural intention towards the metaverse. A technology with high-performance expectancy is more likely to gain alignment and support from various organizational departments and stakeholders, which leads to its adoption (Duarte & Pinho, 2019). Hence, the authors propose the following hypotheses:

H1: Performance expectancy significantly influences the intention to use industrial metaverse

3.2.2 Effort Expectancy

Effort expectancy refers to the user's perception of the ease and simplicity with which they can use a particular technology to accomplish their tasks or goals (Venkatesh et al., 2003). Researchers and practitioners recognize the critical role of effort expectancy in shaping technology adoption rates and usage behaviour (Arpaci et al., 2022; Gupta & Arora, 2020). Users who find technology easy to use and less complicated are more likely to express a higher intention to adopt it (Gursoy et al., 2019). The perceived simplicity and convenience encourage users to explore and adopt the technology (Do Nam Hung et al., 2019). On the other hand, if users perceive technology as difficult to use or requiring a steep learning curve, it may result in resistance to change and lower intentions to adopt the technology (Rahi et al., 2019). Hence, the authors propose the following hypotheses:

H2: Effort expectancy significantly influences the intention to use industrial metaverse

3.2.3. Social Influence

Social influence refers to the impact of social factors and the influence of others on an individual's decision to adopt and use a particular technology (Garone et al., 2019; Venkatesh et al., 2003). Social influence can create a sense of peer pressure, where individuals may feel compelled to adopt the technology to fit in with their social group or maintain social connections (Joa & Magsamen-Conrad, 2022). Social influence shapes perceived norms about technology adoption within a social group (Malik, 2022). If the technology is widely accepted and used by competitors, it can create a social norm that encourages other organizations to adopt that particular technology (Abbad, 2021). The prevailing organizational culture and social norms regarding technology adoption can influence employees' behavioural intentions (Chen et al., 2023). Hence, the authors propose the following hypotheses:

H3: Social influence significantly influences the intention to use industrial metaverse

3.2.4. Facilitating Conditions

Facilitating conditions refer to the extent of support and resources available to users within their organizational and technological environment that facilitate adopting and using a specific technology (Arpaci et al., 2022; Venkatesh et al., 2003). The literature highlights facilitating conditions as one of the crucial variables in understanding organizational intentions to adopt and utilize new technology (Abbad, 2021; Congo & Choi, 2022). High facilitating conditions signal to employees that the organization is prepared and committed to supporting the technology adoption process (Chatterjee et al., 2020). This readiness fosters a positive attitude among employees and encourages them to adopt the new technology (Duarte & Pinho, 2019). Further, a supportive infrastructure and facilitating conditions can enhance overall organizational efficiency (Vairetti et al., 2019). Hence, the authors propose the following hypotheses:

H4: Facilitating conditions significantly influence the intention to use industrial metaverse

3.2.5. Organizational Agility

Organizational agility is the ability of a company to handle fast and unpredictable changes and flourish in a competitive and ever-changing environment (Wamba, 2022; Cheng et al., 2020). Agile organizations are adept at thriving in dynamic and complex situations (Darvishmotevali et al., 2020). They can quickly adapt by introducing new methods and even restructuring when needed (Bi et al., 2014). Organizational agility focuses on meeting customer demands, innovating new products, forming strategic partnerships, and making tough decisions about existing alliances (Arsawan et al., 2022). It involves understanding the organizational environment to seize opportunities that arise (Xie et al., 2022). Agile organizations' willingness to experiment and take risks can lead to the early adoption of innovative technologies, providing them with a competitive advantage and staying ahead in the market (Darvishmotevali et al., 2020). Further, agile organizations quickly adapt to changing market conditions and customer needs (Al-Omoush et al., 2020). Also, agile organizations position themselves for long-term success and sustainability in dynamic and evolving markets, enhancing firm performance. Therefore, the industrial metaverse has the potential to create a sense of organizational agility, which may enhance the firm performance. Hence, the authors propose the following hypotheses:

H5: Intention to use industrial metaverse significantly influences the organizational agility of the firm
H6: The organizational agility of the firm significantly influences the firm performance

3.2.6. Firm Performance

Firm performance refers to evaluating how effectively a company utilizes and integrates a specific technology into its operations and processes (Hoque et al., 2023; Lin et al., 2020). Firm performance is measured by how much the technology contributes to achieving the company's strategic objectives and enhances its overall performance (Quan, 2008). Therefore, adopting the right technologies can streamline and automate processes, which leads to increased efficiency and productivity (Nugroho et al., 2022; Lin et al., 2020). This automation can help reduce manual tasks, which would help optimize the workflow (Sheel & Nath, 2019). Various studies have shown that technology can improve business processes and performance (Hasani et al., 2023; Chang & Wong, 2010; McWilliams & Siegel, 2000). Similarly, the industrial metaverse can also enhance firm performance by providing access to real-time data and analytics, enabling informed decision-making. Hence, the authors propose the following hypotheses:

H7: Intention to use industrial metaverse significantly influences the firm performance

3.2.7 Moderating Role of Firm Innovativeness

In an organization, firm innovativeness is a critical factor that drives innovation at the organizational level (Geng et al., 2022; Tsai & Yang, 2013). It refers to the organization's openness and willingness to embrace new ideas and promote innovation within its culture (Chatman & Cha, 2003). Firm innovativeness reflects the organization's innovative culture, encouraging employees to generate fresh ideas (Menguc & Auh, 2006). While prior literature defines firm innovativeness based on the outcomes of innovation, this study highlights that it is more about fostering a culture that inspires employees to experiment (Yousaf et al., 2020). An innovative firm motivates employees to explore new possibilities, take bold actions, and drive progress through continuous innovation (Geng et al., 2022). Therefore, highly innovative organizations are more likely to proactively adopt and embrace new technologies (Augusto & Coelho, 2009). Hence, the authors propose the following hypotheses:

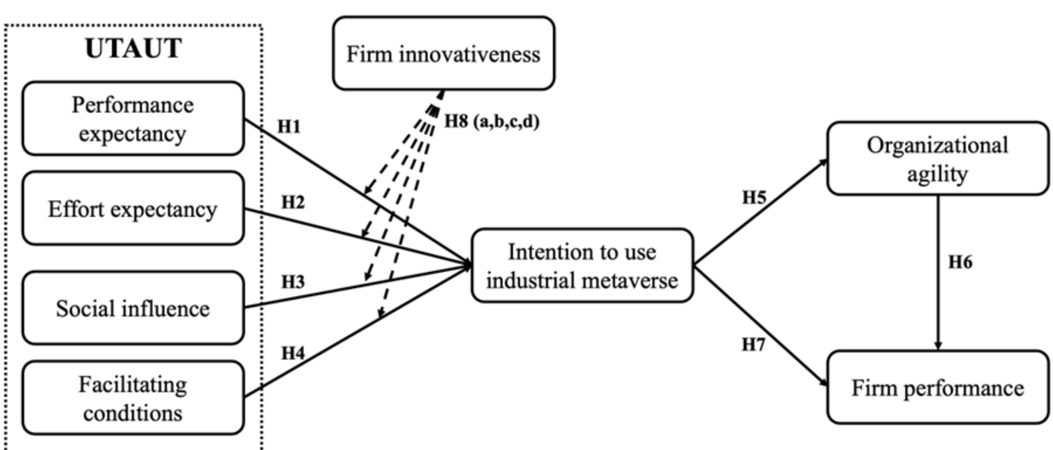
H8: Firm innovativeness significantly moderates the effect of a) performance expectancy, b) effort expectancy, c) social influence, d) facilitating conditions on intention to use industrial metaverse

4. RESEARCH METHOD

4.1. Measures Development

The questionnaire was developed using items obtained from previous literature, however, we ensure that the items suit the context of the study. Specifically, the variables and the sources of items used to measure them were performance expectancy (four items), effort expectancy (four items), social influence (three items), facilitating conditions (four items), intention to use (three items) from Venkatesh et al. (2012); organizational agility (six items) from Wamba (2022); firm performance (six items) from Wamba (2022) and Sheel & Nath (2019); and firm innovativeness from Tsai & Yang (2013). The participants were asked to express their level of agreement or disagreement with

Figure 1. Proposed framework



statements that assessed the variables in the research model. This was done using a 5-point Likert scale, where “Strongly agree” was assigned a value of 5 and “Strongly disagree” was assigned a value of 1. A panel of subject matter experts, consisting of two professors of information systems and two professors of marketing area, has chosen to conduct content testing on the survey instrument. Additionally, a pilot survey with 40 participants was conducted. Minor changes to the questionnaire were made after receiving feedback from the pilot study and expert group.

4.2. Sampling and Questionnaire Administration

An online structured survey was created on Qualtrics (See Appendix 1). We have approached a market research agency for the list of production and operation managers with their email details. A list of 3000 production and operation managers was received, and systematic random sampling for approaching every 5th manager through email from the list received. A reminder mail was sent after one week to fill in the responses. To guarantee the sample’s relevance to our study, a screening question was asked: “Are you aware of industrial metaverse?” and “Is your organization willing to use industrial metaverse in future?” Participants who responded affirmatively to the screening question were allowed to continue with the remaining survey sections. The questionnaire was sent to 600 respondents, and 352 responses were received. Further, we discarded 47 incomplete responses. Therefore, we discarded those responses and were left with 305 (39.6% female) for further analysis. Most respondents belong to the 35-45 age group (39%), following the 25-35 age group (26%). Approximately 18% of responses belong to the 45-55 age group, and the rest of the respondents belong to above 55 years and below 25 age groups.

5. RESULTS

5.1. Reliability and Validity of the Measurement Model

We conducted a confirmatory factor analysis (CFA) for all the considered variables, resulting in a satisfactory model fit ($\chi 2$ /df = 2.62, Tucker–Lewis Index= 0.92, comparative fit index = 0.96, goodness-of-fit index = 0.97, and the RMSEA= 0.06). All items showed sufficient reliability, such as composite reliability (CR) values greater than the standard threshold of 0.70 (Hair et al., 2010). Convergent validity was demonstrated by all items with mean extraction (AVE) values greater than the recommended threshold of 0.50 (Fornell & Larcker, 1981). Furthermore, the discriminatory validity of each construct was maintained, as all individual construct correlation values were less than 0.8 with other constructs (Fornell & Larcker, 1981). Notably, the correlation values between the constructs are less than the square root of the AVE values for each construct, demonstrating discriminant validity (see Tables 1 and 2).

5.2. Common Method Bias (CMB)

We used various methods to check common method bias. One of the methods included items assessing a marker variable conceptually unrelated to other variables in the survey (Lindell & Whitney, 2001). The marker variable had a poor correlation with the other constructs in the research, but the correlation matrix between the marker and the other variables was statistically significant after controlling for CMB. Consequently, CMB cannot explain the outcomes. Further, Harman’s one-factor test (HFT) was used to assess the presence of common method bias. The findings of HFT revealed that one-factor items explained less than the recommended threshold value of 50% of the variation, i.e., 32.71%. This indicates that the study shows no risk of CMB.

5.3 Hypothesis Testing

The structural equation model (CB-SEM) using AMOS 25 was conducted to evaluate the relationship proposed in the research framework. The result of path analysis (see Table 3) indicates that performance

Table 1. Measurement model

Variables and items	FL	ALPHA	AVE	CR
Performance expectancy (Venkatesh et al., 2012)		0.851	0.629	0.865
PE1	0.594			
PE2	0.565			
PE3	0.969			
PE4	0.953			
Effort expectancy (Venkatesh et al., 2012)		0.938	0.788	0.936
EE1	0.792			
EE2	0.985			
EE3	0.775			
EE4	0.978			
Social influence (Venkatesh et al., 2012)		0.750	0.521	0.761
SI1	0.807			
SI2	0.775			
SI3	0.558			
Facilitating conditions (Venkatesh et al., 2012)		0.914	0.727	0.914
FC1	0.894			
FC2	0.873			
FC3	0.828			
FC4	0.814			
Intention to use industrial metaverse (Venkatesh et al., 2012)		0.784	0.548	0.784
INT1	0.721			
INT2	0.729			
INT3	0.771			
Organizational agility (Wamba, 2022)		0.881	0.555	0.881
OA1	0.805			
OA2	0.786			
OA3	0.821			
OA4	0.694			
OA5	0.688			
OA6	0.662			
Firm performance (Wamba, 2022; Sheel & Nath, 2019)		0.963	0.745	0.945
FP1	0.805			
FP2	0.994			
FP3	0.787			
FP4	0.796			
FP5	0.991			
FP6	0.776			
Firm innovativeness (Tsai & Yang, 2013)		0.844	0.717	0.883
FI1	0.839			
FI2	0.826			
FI3	0.875			

Notes: AVE= Average variance extracted, CR= Composite reliability, FL= Factor loading

Table 2. Discriminant validity

Variables	1	2	3	4	5	6	7	8
1. Performance expectancy	0.793							
2. Effort expectancy	0.290	0.888						
3. Social influence	0.174	0.136	0.722					
4. Facilitating conditions	0.266	0.310	0.196	0.853				
5. Intention to use industrial metaverse	0.414	0.136	-0.048	0.255	0.740			
6. Organizational agility	0.285	0.165	-0.005	0.376	0.329	0.745		
7. Firm performance	0.175	0.022	-0.046	0.121	0.208	0.069	0.863	
8. Firm innovativeness	0.321	0.281	0.136	0.439	0.406	0.247	0.136	0.847

Notes: Diagonal value represents √AVE

Table 3. Direct relationship

Path	Beta	SE
Performance expectancy → Intention to use industrial metaverse	0.410***	0.071
Effort expectancy → Intention to use industrial metaverse	-0.018ns	0.051
Social influence → Intention to use industrial metaverse	0.164**	0.059
Facilitating conditions → Intention to use industrial metaverse	0.221**	0.052
Intention to use industrial metaverse → Organizational agility	0.368***	0.102
Organizational agility → Firm performance	-0.017ns	0.071
Intention to use industrial metaverse → Firm performance	0.234**	0.111

Note: *** implies p is less than 0.001; ** implies p is less than 0.01; * implies p is less than 0.05; ns implies not significant

expectancy (Effect= 0.410, p<0.001), social influence (Effect= 0.164, p<0.01) and facilitating conditions (Effect= 0.221, p<0.01) are significantly associated with intention to use industrial metaverse. Therefore, **H1, H3,** and **H4** are supported. Moreover, the intention to use industrial metaverse is significantly associated with organizational agility (Effect= 0.368, p<0.001) and firm performance (Effect= 0.234, p<0.01). Therefore, **H5** and **H7** are supported. However, the association between effort expectancy (Effect= -0.084, p˃0.05) and intention to use the industrial metaverse is not significant. Therefore, **H2** was not supported. Also, the relationship between organizational agility (Effect= -0.017, p˃0.05) and intention to use the industrial metaverse was not significant. Hence, **H6** was not supported. The R^2 value for intention to use the industrial metaverse is 0.248, indicating that the predictor variables adequately explain the proposed conceptual model. The goodness-of-fit indices indicate that the model fit is acceptable (CMIN/DF = 2.58 (*p*<0.001), CFI= .91, GFI= .94, TLI= .92, RMSEA= .06) (Hair et al., 2010).

5.4 Moderation Analysis

To test the moderation hypotheses, we used bootstrap estimates from 5000 samples using Model 1 in Process Macro (Hayes, 2013). Table 4 shows that the influence of performance expectancy (Effect= 0.113; LLCI= 0.045, ULCI= 0.182) and social influence (Effect= -0.094; LLCI= -0.182, ULCI= -0.006) towards intention to use the industrial metaverse is significantly moderated by firm innovativeness, thereby supporting **H8a and H8c**. However, the influence of effort expectancy (Effect= -0.058; LLCI= -0.131, ULCI= 0.015) and facilitating conditions (Effect= -0.016; LLCI=

Table 4. Moderation analysis (Firm innovativeness)

Path (Moderating effect of firm innovativeness)	Effect	SE	LLCI	ULCI
Performance expectancy → Intention to use industrial metaverse	0.113	0.035	0.045	0.182
Effort expectancy → Intention to use industrial metaverse	-0.058	0.037	-0.131	0.015
Social influence → Intention to use industrial metaverse	-0.094	0.045	-0.182	-0.006
Facilitating conditions → Intention to use industrial metaverse	-0.016	0.040	-0.095	0.064

-0.095, ULCI= 0.064) towards intention to use the industrial metaverse is not significantly moderated by firm innovativeness. Hence, rejecting **H8b and H8d**. Table 5 highlights the high and low levels of moderation results.

5.5. Artificial Neural Network (ANN) Analysis

Further, based on SEM, we ranked the normalised relevance of the crucial predictors using artificial neural networks (ANN). In the following step, the input neurons for the ANN model were derived from the significant variables identified in the CB-SEM path analysis (see Figure 2). IBM SPSS was used to perform ANN. ANN has the capability to identify the non-linear relationships in the model with the help of a "black box" solution. A sensitivity analysis was conducted to assess the predictive capacity of each input neuron by normalizing the relative weight of each neuron to its maximum value and expressing the outcome as a percentage. The findings in Table 6 reveal that performance expectancy (100%) is the most important predictor of intention to use the industrial metaverse. Further, the normalised importance of independent variables is followed by facilitating conditions (34.4%) and social influence (20.6%), respectively.

6. DISCUSSION

The present paper attempted to investigate the association between UTAUT variables and the intention to use the industrial metaverse. Prior literature has examined the effect of UTUAT variables on various behavioural outcomes (Arfi et al., 2021; Chatterjee et al., 2021; Jadil et al., 2021). Nevertheless, scant

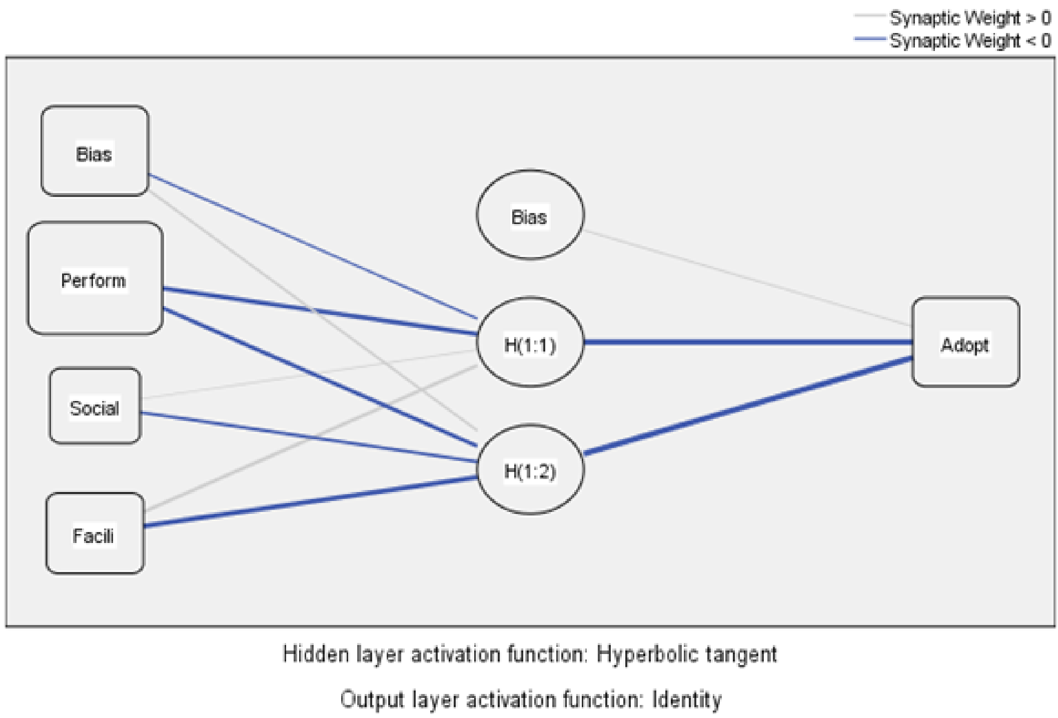
Table 5. Moderation effects at low and high levels

Path (Moderating effect of firm innovativeness)	Level	Effect	SE	LLCI	ULCI
Performance expectancy → Intention to use industrial metaverse	Low	0.168	0.052	0.065	0.271
	High	0.394	0.055	0.286	0.502
Social influence → Intention to use industrial metaverse	Low	0.128	0.069	-0.007	0.263
	High	-0.060	0.069	-0.197	0.076

Table 6. Sensitivity analysis

Variable	Importance	Normalized Importance
Performance expectancy	0.654	100.0%
Facilitating conditions	0.212	32.4%
Social influence	0.135	20.6%

Figure 2. Artificial neural network diagram



efforts were made to examine the empirical linkage between UTAUT variables and industrial metaverse adoption intention. Therefore, this research proposed to address this gap using the UTAUT framework.

The findings of this study reveal that performance expectancy, social influence and facilitating conditions are significant predictors of intention to use the industrial metaverse, which is consistent with the prior literature in other contexts (Chatterjee et al., 2021; Jadil et al., 2021).

A few probable reasons for the above results may be that organizations perceive that using the industrial metaverse will have a visible and measurable impact on their job performance, enhancing their overall productivity (Sjakir et al., 2015). Therefore, organizations believe that the industrial metaverse will enable them to achieve tasks more effectively and deliver higher-quality results. Further, many organizations are already investing billions into their metaverse space, which creates a sense of pressure to adopt the technology as soon as possible (McKinsey & Company, 2022a). Finally, organizations feel confident they have the competence to use the industrial metaverse effectively. Organizations find it convenient to adopt the technology as it fits naturally into their workflow. Further, contrary to the prior literature in other contexts (Al-Saedi et al., 2020; Wang et al., 2020; Venkatesh et al., 2003), effort expectancy does not significantly influence intention to use the industrial metaverse. One of the probable reasons for this result may be attributed to the adequate training and ongoing support provided to users during the adoption process, which mitigated the perceived challenges or complexities of using metaverse.

The study results have highlighted that intention to use the industrial metaverse was a statistically significant predictor of organizational agility and firm performance. Embracing the industrial metaverse indicates a proactive approach to innovation and adaptability, leading to improved organizational agility. Technology integration likely enhances operational efficiency, contributing to organizational responsiveness (Wamba, 2022). Furthermore, leveraging the metaverse's capabilities may improve productivity which may positively impact overall firm performance. This strong relationship underscores the importance of industrial metaverse adoption in driving organizational success. Moreover, the results revealed that organizational agility was not associated with firm performance. One probable reason for this result could be the newness of the technology, and the true potential may have yet to be realized. Therefore, although organizations embrace agility in adopting the technology, the overall impact on firm performance may not be fully evident.

Similarly, consistent with prior literature (Ranjan & Nayak, 2023; Rahman et al., 2020), the moderating effect of firm innovativeness was found to be significant. In addition, the effect of performance expectancy and social influence on intention to use the industrial metaverse varies at high and low levels of firm innovativeness. Therefore, firms with a high degree of innovation culture within their organizations are likelier to adopt the industrial metaverse than those with low innovativeness.

7. IMPLICATIONS

7.1. Theoretical Implications

The study offers many theoretical implications. The current study is pioneering research examining behavioural intentions towards the industrial metaverse. The findings shed light on the key determinants that shape employees' attitudes and behaviours towards adopting this cutting-edge technology. Overall, the results contribute valuable insights to the field of technology acceptance and provide practical implications for organizations aiming to harness the potential of the industrial metaverse. The results of this research enrich the existing literature on UTAUT by providing empirical evidence that supports the framework. The UTAUT framework brings together crucial determinants influencing an individual's intention to adopt and use technology (Venkatesh et al., 2003). UTAUT has been extended and adapted to different contexts, making it a foundational model for researchers and practitioners to investigate and understand the factors that drive technology acceptance and usage among consumers (Arpaci et al., 2022; Duarte & Pinho, 2019; Chaudhary & Suri, 2018; Kwateng et al., 2018). Therefore, the findings of this study show that performance expectancy, social influence and facilitating conditions are significant factors that enhance the intention to use the industrial metaverse. Further, as per the authors' knowledge, no study identified the significant variables associated with the intention to use the industrial metaverse. Therefore, this study contributes significantly to the literature by investigating a novel phenomenon. The study also contributes to the technology adoption literature. Finally, this study contributes to the firm innovativeness literature by investigating the moderating effect of firm innovativeness in the B2B context.

7.2. Practical Implications

The present research also offers several managerial implications. The findings of this study will help managers and organizations' leadership understand the factors associated with the intention to use the industrial metaverse. The findings of this study reveal performance expectancy, social influence and facilitating conditions to be the significant predictors of intention to use the industrial metaverse. To enhance the influence of performance expectancy, organizations should run small-scale pilot projects to demonstrate tangible outcomes and success stories of the industrial metaverse. Further, the achievements and positive results achieved through using the industrial metaverse could be highlighted in front of the employees. To enhance social influence, organizations should identify and encourage "champions" and early adopters of the technology within their organizations. These individuals can act as advocates and help influence their peers positively. Also, organizations should allocate adequate resources to build technology infrastructure to successfully adopt the industrial metaverse. Organizations should implement effective data management practices to handle the vast amount of data generated within the metaverse. This includes data storage, security, and analytics capabilities. This would also help organizations address data privacy concerns by implementing robust security measures. Also, organizations should ensure compliance with relevant regulations to safeguard sensitive information within the metaverse.

Finally, the intention to use the industrial metaverse positively influences organizational agility and firm performance. Therefore, organizations should ensure that the technology supports and enhances agility initiatives which contribute directly to improving firm performance (Al-Omoush et al., 2020). Further, organizations should implement virtual product development and prototyping processes within the metaverse. This can significantly reduce development timelines and costs, which leads to enhancing overall firm performance. The study results also reveal firm innovativeness as a significant moderator. Therefore, organizations should inculcate a culture of innovation within the firm (Tsai & Yang, 2013). Further, collaboration across departments and teams is encouraged to foster diverse perspectives and ideas. Finally, organizations should ensure that top leadership actively supports and participates in innovation initiatives by allocating resources and budgets for innovation projects.

8. LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

Despite the implications provided by the present study, this research suffers from a few limitations. This study uses cross-sectional data. However, future researchers could use longitudinal data to examine the proposed framework of pre-adoption and post-adoption of the industrial metaverse. The present study examines the intention to use the industrial metaverse using the UTAUT framework; however, future researchers could also include status quo bias theory into the framework to see which factors could act as a resistance to the adoption behaviour. Future researchers could also extend the given framework by using the dual-factor model theory, which would help the researchers to identify the trade-off between benefits and risks while adopting the industrial metaverse in their organizations. Finally, the present study was performed in the B2B context, and future researchers could examine the same framework in the B2C context.

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APPENDIX 1

Construct items with literature sources

Variables and items (Literature sources)
Performance expectancy (Venkatesh et al., 2012)
PE1: I find industrial metaverse useful in my daily
PE2: Using industrial metaverse increases my chances of achieving things that are important to me
PE3: Using industrial metaverse helps me accomplish things more quickly
PE4: Using industrial metaverse increases my productivity
Effort expectancy (Venkatesh et al., 2012)
EE1: Learning how to use industrial metaverse is easy for me
EE2: My interaction with industrial metaverse is clear and understandable
EE3: I find industrial metaverse easy to use
EE4: It is easy for me to become skilful at using industrial metaverse
Social influence (Venkatesh et al., 2012)
SI1: People who are important to me think that I should use industrial metaverse
SI2: People who influence my behaviour think that I should use industrial metaverse
SI3: People whose opinions that I value prefer that I use industrial metaverse
Facilitating conditions (Venkatesh et al., 2012)
FC1: I have the resources necessary to use industrial metaverse
FC2: I have the knowledge necessary to use industrial metaverse
FC3: Industrial metaverse is compatible with other technology
FC4: I can get help from others when I have difficulties using industrial metaverse
Intention to use industrial metaverse (Venkatesh et al., 2012)
INT1: I intend to continue using industrial metaverse in the future
INT2: I will always try to use industrial metaverse in my life
INT3: I plan to continue to use industrial metaverse frequently
Organizational agility (Wamba, 2022)
OA1: My firm easily and quickly respond to changes in aggregate consumer demand
OA2: My firm easily and quicky customizes a product or service to suit an individual customer
OA3: My firm easily and quickly reacts to new product or service launches by competitors
OA4: My firm can easily and quickly introduces new pricing schedules in response to changes in competitors' prices
OA5: My firm easily and quickly expands into new regional or international markets
OA6: My firm easily and quickly changes (i.e., expand or reduce) the variety of products/services available for sale
Firm performance (Wamba, 2022; Sheel & Nath, 2019)
FP1: We are more profitable than our competitors by using industrial metaverse
FP2: Level of service provided to customers will be improved by using industrial metaverse
FP3: Transaction cost of operations will be reduced by using industrial metaverse
FP4: Speed of operations will be improved by using industrial metaverse
FP5: Overall, our performance is better than our competitors by using industrial metaverse
FP6: Value creation in the organization will be improved by using industrial metaverse
Firm innovativeness (Tsai & Yang, 2013)
FI1: Innovation is readily accepted in management
FI2: Our company encourages and supports innovative activities
FI3: New ideas are quickly accepted in our company

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