Computers and Education Open 10 (2026) 100340

Contents lists available at ScienceDirect

Computers and Education Open

journal homepage: www.sciencedirect.com/journal/computers-and-education-open

Metaverse adoption among university Generation Z in Malaysia and Saudi Arabia: A cross-cultural analysis of individual, social and ethical impacts

Norah Basheer Alotaibi

Department of Social Work, College of Humanities and Social Sciences, Princess Nourah bint Abdulrahman University, P.O. Box 84428, Riyadh 11671, Saudi Arabia

ARTICLE INFO

Keywords:
Metaverse adoption
University Generation Z
Cross-cultural comparison
Metaverse and social impacts
Metaverse and ethical impacts
Metaverse and individual impacts

ABSTRACT

Changes in the fields of education, entertainment, and social interaction have been generally attributed to an immersive, data-intensive environment referred to as the metaverse. In this study, the main objective is to examine statistical associations between UTAUT/PMT constructs and metaverse adoption, and between adoption and perceived individual, social, and ethical outcomes, in two university student samples. The study proposes a calibrated extended UTAUT version through the incorporation of PMT's coping appraisal, with self-efficacy and facilitating conditions considered as coping capacity (response efficacy), and curiosity/exploration considered as an adaptive driver under uncertainty. This cross-sectional survey study obtained 620 survey data from Malaysia and Saudi Arabia, after which they were exposed to PLS-SEM, with MICOM for establishing measurement invariance, and PLS-MGA for group comparison. The study found UTAUT's main drivers, namely performance expectancy, effort expectancy, and social influence, to be the main predictors of adoption in the two countries, in addition to self-efficacy, technological aptitude, and learning motivation. Based on the findings, there were three major cross-country differences, one of which is the parental support and facilitating conditions, which appeared stronger in Malaysia, and secondly, curiosity/exploration was found to be higher in Saudi Arabia. Moreover, a positive relationship was found between adoption and perceived benefits across individual, social, and ethical dimensions. According to the outcome of the robustness tests that control for metaverse experience for both countries and gender for the sample from Saudi Arabia, produced consistent patterns. Notably, the findings need to be interpreted for Gen Z university students based on a platform-agnostic design. Accordingly, coping capacity was found to contribute value beyond UTAUT in immersive contexts and provides culturally sensitive levers for stakeholders, particularly policymakers, educators and developers, while laying down directions for future studies that are probability-based, platform-stratified, and longitudinally designed. Because the design is cross-sectional and uses non-probability sampling, all inferences are correlational; reported paths reflect statistical associations rather than causal effects, and generalizability is limited to similar student populations.

1. Introduction

Conceptually, the metaverse in its immersive, data intensive constellation of virtual, augmented and mixed-reality technologies forms, has shifted towards practice, resulting in changes in learning, collaboration and socialization of people [1–3]. More recently, relevant innovations, boosted by the pandemic-era digitalization, have led to innumerable progress in VR with Artificial Intelligence, IoT, cloud computing, and big data analytics [1,4,5]. Such progress has led the way to richer experiences, but this goes hand in hand with concerns regarding surveillance, equity, privacy, and well-being of users [1,6–8].

Viewed from the IS perspective, AI-driven capabilities in the metaverse, such as immersive learning, intelligent decision-making, support, and human-virtual collaboration, can enrich the experiences of the user and minimize operational glitches when appropriately managed [9–13]. This is particularly evident in educational and cultural-memory settings, where current metaverse studies highlighted the way stakeholder preparedness such as, user guidance and librarian's competencies play a role in adoption and perceived value [13]. Nevertheless, additional research is still called for to explore the adoption of metaverse among young users and how such adoption is linked to their perceived individual, social and ethical outcomes [14–20].

In the majority of studies aligned with the topic of immersive contexts, the Unified Theory of Acceptance and Use of Technology (UTAUT) has been used as the underpinning theory that covers performance expectancy, effort expectancy, social influence, and facilitating conditions

E-mail address: dr.norah.alotaibi@gmail.com.

https://doi.org/10.1016/j.caeo.2026.100340
Received 10 July 2025; Received in revised form 25 December 2025; Accepted 17 February 2026
Available online 18 February 2026

[21]. Having this in mind, in an environment that is data-intensive, users perceive risks and consider their coping levels and thus, UTAUT is integrated with Protection Motivation Theory (PMT), with coping appraisal considered as the mechanism that transforms perceived usefulness and ease into actionable adoption. In framing the proposed model, this study considered self-efficacy and facilitating conditions for index coping capacity (response efficiency), and curiosity/exploration for adaptive information-seeking under uncertainty [9,19]. The integration of UTAUT with PMT is used beyond just a checklist, but rather the expectation that the likelihood of adoption is higher when the metaverse appears worthwhile, and users perceive their ability towards risk management.

The comparison between Malaysia and Saudi Arabia indicated meaningful theoretical differences in light of family norms, institutional support, and uncertainty management, enabling the observance of the way parental support (family social capital), curiosity/exploration, and facilitating conditions, salient differences [1,2]. Following a compact cross-cultural lens, in consideration of collectivism and parental mediation, power distance and institutional trust, uncertainty avoidance and exploration, it is expected that parental support and facilitating conditions contribute significantly, with visible encouragement and resources, and with curiosity/exploration having a role in adaptive uncertainty management in terms of boosting engagement [9,20,22].

The focus of this platform-agnostic study is placed on Generation Z university goers in Malaysia and Saudi Arabia. The design is opted for to preserve cross-country comparability and explicitly scope the claims similar to the populations of the students. The use of non-probability purposive sampling through university channels makes for limited generalizability of findings to the entire Gen Z or the working youth – this is clarified in Methods and Limitations with reports of robustness checks controlling for metaverse experience of both countries and both genders for the Saudi sample [23].

As mentioned, the Unified Theory of Acceptance and Use of Technology is used in combination with Protection Motivation Theory's coping appraisal to shed insight into the metaverse adoption of Generation Z enrolled in universities in Malaysia and Saudi Arabia. The study is guided by the four major research questions, which are as follows: RQ1: Which UTAUT and PMT-derived constructs are top predictors of metaverse adoption among university Gen Z?, RQ2: Do these top predictors differ between Malaysia and Saudi Arabia? RQ3: What are the unique insights that emerge from comparing Malaysia and Saudi Arabia? RQ4: What is the relationship between adoption and perceived individual, social and ethical outcomes of each country examined?

The paper follows an organized structure to present the metaverse research effectively. Accordingly, Section 2 of this paper provides an extensive literature review of past relevant studies and scholarly works relating to the topic. Section 3 is dedicated to developing the model and formulating hypotheses, based on which a theoretical framework is developed to conceptualize and elucidate the factors and their interconnections to the metaverse. Section 4 deals with the presentation of methodological considerations, beginning with the research design, data collection procedure and ending with the methods adopted for analyzing data. This is followed by Section 5, which forms the basis for the presentation of the empirical findings obtained from the study, and Section 6, which provides the discussions and interpretations of the same. Section 7 provides the research implications and significance as well as its potential applications, and in Section 8, direction for future studies on the metaverse. Lastly, Section 9 marks the paper's conclusion and summarizes the major findings and study contributions. The paper used a systematic and well-structured framework, ensuring a robust and organized research presentation and facilitating an all-encompassing metaverse analysis.

2. Related works

The portrayal of the metaverse as a driver of achieving experiences that were once impossible – varying from volcanic exploration to deep-sea immersion- has been made possible through the developments in immersive and interactive technologies [24,25]. Hand in hand with this ability is the recent studies of a 'dark side' that arises in the absence of sufficient governance, the presence of risks related to identity, equity, surveillance, and safety that can increase like technologies characterized by high-connectivity [1,3,7,16,26,27]. Past studies have had a tendency towards optimism and descriptiveness, while current ones beg for balanced, evidence-based findings that consider value creation along with the potential risks [9,24].

There is a notable lag when it comes to adoption in language education, notwithstanding the interactive affordances of the metaverse, requiring a comprehensive design-pedagogy-technology-learning framework for implementation success [28]. Based on a bibliometric review of 310 publications from 2004 to 2022, whose interest caught traction from 2019, there are eight repetitive themes that arise, namely metaverse-based physical education, immersive language learning, metaverse-enabled STEM labs, and gameful learning. The review also highlighted constant challenges in data security, real-virtual identity balance, instructor readiness, and higher-order thinking assessment [29]. Educational applications were also catalogued in a study that laid emphasis on the use of technologies (e.g., XR, IoE) and ethical safeguards for effective use in education [30]. Along a similar line, reviews involving several sectors position the metaverse as an extension of the physical reality through VR and related technologies, with expected effects in healthcare, marketing, tourism, and others [9,25].

Added to the above, based on studies on industry-facing strategy, there is a typology of fashion-brand approaches that are related to brand-equity outcomes, and this provides a framework for future studies and doable strategies [31]. Infrastructure-wise, a security-management model for communication networks in a metaverse-based cultural consumption determined several major psychosocial factors that are susceptible to risk, and thus the 3E rules (engineering, education, enforcement) were proposed as actionable precautionary safeguards [32]. In another related study, work on marketing expected changes in consumer research and practice with the maturity of immersive channels [24].

In line with these studies and homed in Generation Z, the following factors are stressed on – co-creation, social presence, and cultural engagement. And in the tourism sector, mixed reality and metaverse experiences are contended to be the factors modernizing cultural-heritage encounters and foregrounding participation of Gen-Z [9]. Moreover, in the context of Gen-Z in museums, metaverse applications serve as immersive edutainment, boosting connections to artefacts and heritage while attracting co-creation of visitors [33]. In the South Korean example, platform-specific evidence indicated that higher social presence in Roblox and Zepeto predicts higher levels of supportive collaboration and social efficacy and lower levels of loneliness – this highlights the contribution of socio-psychological mechanisms to the Gen-Z outcomes [34].

Past studies across domains showed that the value of metaverse hinges on the capacity of users to manage risk and on the institutional and communal supports in addition to the perceived usefulness and use of users [9,29,30]. This directs the use of an integrative lens combining utility-oriented drivers like UTAUT's performance expectancy, effort expectancy, social influence and facilitating conditions, with coping capacity like PMT's self-efficacy and response efficacy to evaluate relationships at the individual, social, and ethical levels of university-goers. Owing to the variations of the relationships between technology and acceptance based on cultural value orientations, the use of multi-group analysis is suitable to determine these differences in cross-cultural situations [35–39]— accordingly, the determinants are jointly modelled with comparison between Malaysia and Saudi Arabia. Such synthesis directly reveals the presentation of hypotheses of the study and the proposed empirical model in the next sections.

Table 1 presents a summary of the most recent studies that are

Table 1
Summary of key literature on metaverse.

Study	Focus Area	Methodology	Structure/ Approach	Key Findings
[24]	Metaverse as a transformative tool	Expert multi-perspective qualitative analysis	14 expert contributions on metaverse risks	Explores how the metaverse enables immersive experiences, but also warns about governance challenges and potential negative impacts.
[17]	Risks and governance of the metaverse	Critical literature review	Risk-centred thematic literature review	Highlights governance concerns and risks associated with metaverse technology, calling for regulatory oversight.
[28]	Metaverse in language education	Framework development	Pedagogical-technical integration framework	Proposes a framework for integrating the metaverse into language education, addressing design, pedagogy, and technology gaps.
[29]	Research trends in edu-metaverse	Bibliometric and content analysis	310 academic works analyzed from 2004 to 2022	Analyzes 310 studies, identifying key research themes and challenges such as security risks, virtual identity balance, and instructor preparation.
[40]	Metaverse and e-commerce	Quantitative – SEM	Model linking gamification to purchase intention	Examines how immersive technologies in the metaverse shape consumer behavior, using structural equation modeling (SEM) to analyze purchase intentions.
[31]	Metaverse strategies in fashion	Qualitative content analysis	Brand equity typology from fashion trade sources	Analyzes trade journals to develop a framework for metaverse adoption strategies in the fashion industry.
[32]	Security management in metaverse networks	Security model simulation	3E rules: Engineering, Education, Enforcement	Introduces a security management model using mobile gaming to tackle cybersecurity threats in the metaverse.
[41]	Learning and collaboration in the metaverse	Theoretical argument	Reframing metaverse as interactive metaphor	Argues that metaverse should be conceptualized as an interactive and accessible platform beyond high-end virtual reality.
[30]	Metaverse in education	Systematic review (PRISMA)	Applications, ethics, and enabling technologies	Systematic review identifies applications, challenges, and ethical concerns of metaverse integration in education.
[15]	Generation Z and immersive tourism	Qualitative – interviews	Tourism co-creation with MR and the metaverse	Examines how mixed reality (MR) and the metaverse enhance tourism experiences and cultural heritage engagement.
[33]	Museums and digital transformation	Case study analysis	Immersive cultural content for Gen Z learning	Studies how museums use the metaverse to provide immersive cultural experiences and edutainment for Generation Z.
[34]	Social benefits of the metaverse for Gen Z	Survey-based quantitative analysis	Impact on collaboration, loneliness, and self-efficacy	Investigates how metaverse platforms (Roblox, Zepeto) improve social presence, collaboration, and self-efficacy while reducing loneliness.

relevant to this research, highlighting their key focus areas and findings.

3. Model development and hypotheses formulations

In this study, a metaverse adoption is developed and proposed in the context of university-going Generation Z through the combination of the Unified Theory of Acceptance and Use of Technology (UTAUT) and Protection Motivation Theory coping appraisal (PMT). Specifically, UTAUT sheds insight into the intention and use through performance expectancy, effort expectancy, social influence, and facilitating conditions, with its robust explanatory power throughout different technologies [42–47]. Added to the above, the adoption and acceptance of an immersive, data-intensive environment also hinge on the user's feeling of their ability to manage privacy, security and ethical risks. This is captured by incorporating PMT in order to leverage its explanation of protective responses to perceived threats and risks [48] and its extensive application to technology situations that entail ethics, security and privacy [42,49–52].

The contribution of this study takes on an incremental and precise solution by combining UTAUT's utility-centred drivers with the coping appraisal of PMT to shed light on adoption and to relate it to perceived individual, social, and ethical outcomes for Gen-Z university-goers. Such a combination of both self-efficacy and facilitating conditions is operationalized as coping capacity, under which confidence and response efficacy are categorized. This is complementary to performance/effort and social influence. At the same time, curiosity/exploration encapsulates adaptive information-seeking under uncertainty, and lastly, learning motivation and technological aptitude reflect the capabilities of

Gen-Z that form their use and coping that transforms into practice [43–45,53].

The model, as presented in Fig. 1, maintains the core constructs of UTAUT (performance expectancy, effort expectancy, social influence, and facilitating conditions) and extends them by including self-efficacy (coping capacity), parental support (family, social capital), technological aptitude, curiosity/exploration, and learning motivation. In past studies, these additional constructs are consistent in theory and meaningful in empirical findings for immersive learning, youth and ethics-sensitive situations [42,49,52,53].

In classical UTAUT, the moderating factors are age, gender and experience but these are excluded in the main model owing to two primary reasons, the first of which the narrow design adopted and the relatively homogenous age cohort (university Gen Z), which may associated with limited theoretical age variance and that of the experience using technology [45,53]. The second reason for the exclusion is the objective to produce a parsimonious structural model that targets theorized mechanisms among focal constructs [9,53,54]. Owing to the gender imbalance in the Saudi universities, this is statistically addressed through the estimation of the model's robustness, controlling for gender in the Saudi sample, while maintaining the main model's interpretable and theory-driven outcome.

Literature evidences the extensive use of UTAUT for evaluating behavioral intention towards innovative technologies but the combination of UTAUT and PMT makes it more appropriate to examine immersive, risk-aware contexts, youth-salient determinants, namely parental support, curiosity/exploration, learning motivation, technological aptitude, and self-efficacy and facilitating conditions, as well as links from adoption to perceived individual, social, and ethical outcomes for Gen-Z university goers. While steering clear of over-claiming, this developed scope clarifies the added value of the model from the UTAUT-only specifications [42–46,53].

UTAUT explains adoption via utility-oriented appraisals—performance expectancy, effort expectancy, social influence, and facilitating conditions—under relatively stable task and risk conditions [46,53]. By contrast, metaverse use is immersive and data-intensive, with persistent identity, algorithmic mediation, and context collapse that heighten uncertainty and perceived exposure (privacy, safety, ethical norms). In such settings, adoption also depends on whether users believe they can cope with salient risks. Protection Motivation Theory (PMT) specifies two appraisals: threat appraisal (how severe/likely are adverse outcomes) and coping appraisal (can I handle them? Do available responses work? What will they cost?) [42,48–50,52]. We therefore integrate PMT's coping appraisal with UTAUT so that adoption reflects both the perceived worth of metaverse use (utility routes) and the perceived ability to use it safely and effectively (coping routes). In our model, self-efficacy captures users' confidence to navigate immersive features and manage exposure, while facilitating conditions index the response efficacy and accessibility of supports (training, safeguards, compatibility). Youth-salient resources—parental support (family social capital), technological aptitude, learning motivation, and curiosity/exploration—shape how utility and coping translate into

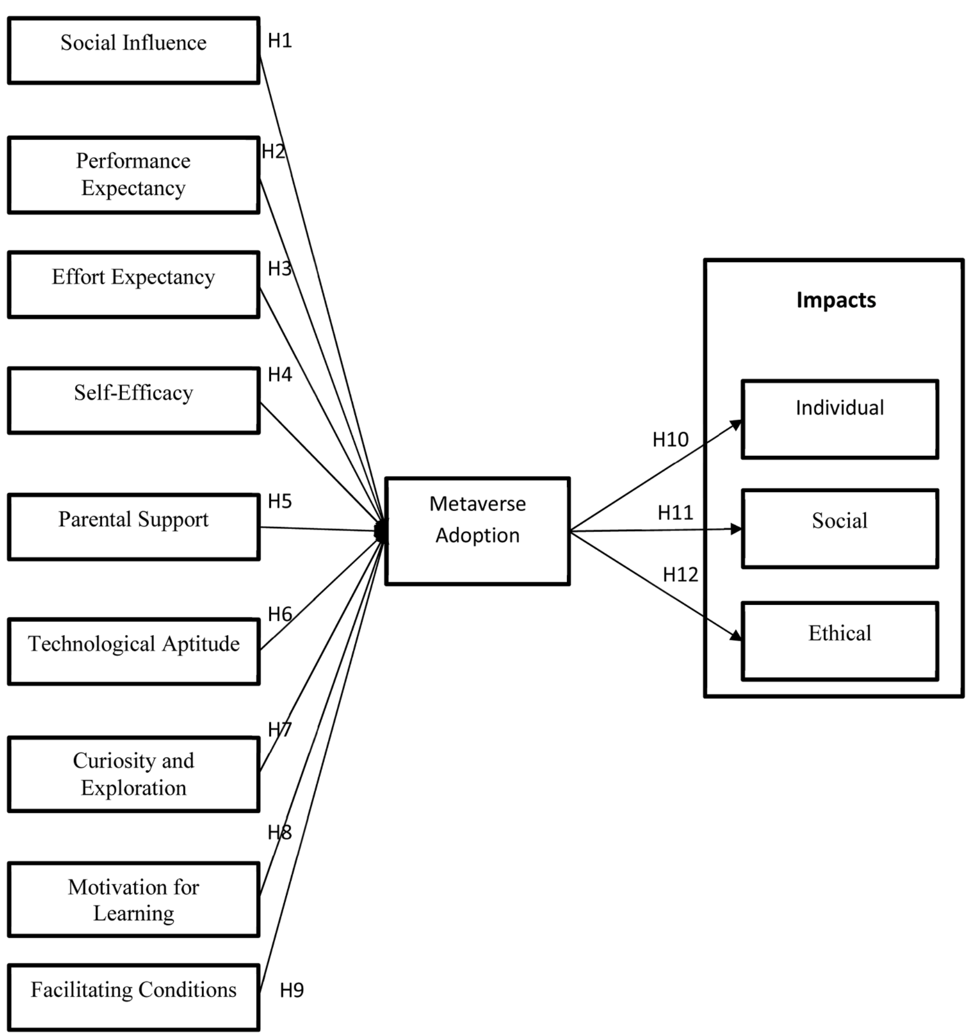

Fig. 1. Conceptual model and hypotheses.

enactment for university Gen Z [42,46,48,53].

Consistent with this integration, we expect adoption to rise when utility (performance, effort, social influence) and coping capacity (self-efficacy; facilitating conditions as response efficacy) are both strong, with youth-salient resources (parental support, technological aptitude, learning motivation, curiosity/exploration) conditioning this translation [42,46,48,53].

In the metaverse, adoption should increase when students perceive both utility (UTAUT: performance, effort, social influence) and coping capacity (PMT/UTAUT: self-efficacy; facilitating conditions as response efficacy), with youth-salient resources shaping how utility and coping translate into enactment. Basing the arguments on existing literature and literature frameworks, the study develops a conceptual model that includes the factors elucidated in the following sections.

3.1. Social influence

The Social influence reflects the extent to which important others believe an individual should use a system [21,46]. This study denotes how peers, instructors, and close contacts shape Generation Z's inclination to use metaverse technologies in study and daily activities [42]. Prior research links social influence to the adoption of diverse technologies [42,43,45,55,56] and to metaverse intentions specifically [57,58]. Within our integrated framing, social cues and credible peer use can reduce ambiguity and perceived risk in immersive environments, complementing utility appraisals by signalling acceptable, endorsed use. Thus, the study hypothesises:

H1. *Social influence is positively associated with metaverse adoption among university Gen Z.*

3.2. Performance expectancy

Performance expectancy is characterized by the extent to which an individual is confident that utilizing the system will aid in achieving improved job performance [21,44,46]. In this study, the construct is the belief of Generation Z that using the metaverse in their daily work and activities can reap benefits. People are more likely to use technology if they are convinced of its advantages compared to traditional methods [42,53,54]. Prior scholarly works have corroborated the connection between performance expectancy and the intention to adopt technology [43,47,56]. This confirmed that performance expectancy contributes to behavioral intention towards metaverse integration and use [58], and based on the benefits obtained, individuals view the metaverse as capable of enhancing their productivity and will thus leverage its use.

Within our integrated framing, performance expectancy provides the utility route to adoption and operates alongside coping capacity (e.g., self-efficacy; facilitating conditions as response efficacy) to convert value perceptions into enacted use under uncertainty. Thus, this study proposes the following hypothesis;

H2. *Performance expectancy is positively associated with metaverse adoption among university Gen Z.*

3.3. Effort expectancy

The ease of using the system is referred to as effort expectancy [21,46], and in the context of this study, it is the belief of Generation Z that the metaverse is easy to use in their daily work and activities. In this regard, individuals would have a higher tendency to refrain from using complicated technology or those with high level of demand for secure operations. Studies along this line have acknowledged that effort expectancy is a significant predictor of the inclination of individuals to use technology [43,56], while others evidenced its positive influence over the behavioral intention of users towards metaverse use [58,59]. In a related study, Arpaci et al. [57] examined metaverse adoption and found the significant impact of effort expectancy on the behavioral intentions of users. It can thus be stated that Generation Z will be more willing to be involved in using the metaverse if they are convinced that it is easy to use. Conceptually, simpler interfaces lower response costs in uncertainty-laden settings, helping students translate perceived usefulness into enacted use alongside coping-capacity levers (e.g., self-efficacy; facilitating conditions). Thus, this study proposes that;

H3. *Effort expectancy is positively associated with metaverse adoption among university Gen Z.*

3.4. Self-Efficacy

According to Bandura [60], self-efficacy is the ability of the individual to carry out a task and when juxtaposed to the context of this study, it refers to the capabilities of Generation Z to make use of metaverse products in their everyday activities. On the other hand, indiviudlas who are not sufficiently exposed to technology intimidated by its use and may not have the capacity to use it in their task completion [61]. Technology exposure can assist in boosting the confidence of the user in their ability towards use. Related literature shows that self-efficacy has a significant influence over the adoption of different technological innovations [50,62]. Similarly, the awareness and perception of the metaverse among regular technology users was measured in Sebastian [63] study, and based on the findings, self-efficacy has a significant effect on the behavioral intention of the users. Self-efficacy was also found to be a significant predictor of users' behavior towards metaverse use. Thus, it can be stated that there is a likelihood that Generation Z would use the metaverse if they are capable and confident in its usage. In our integrated account, self-efficacy operates as coping capacity: confidence to navigate immersive features and manage privacy/identity exposure enables students to act on perceived utility under uncertainty.

This study proposes that;

H4. *Self-efficacy is positively associated with metaverse adoption among university Gen Z.*

3.5. Parental support

Parental support refers to the level of support and guidance that the parents of Generation Z provide to their children in their metaverse engagement [64], and it therefore has a key role in such technology engagement [65]. In past studies, parental involvement has been shown to promote positive attitudes and behaviors among children toward technology adoption [66]. Active support and guidance from parents to children in technology use provides a sense of comfort and confidence, and ultimately minimizes potential risks and challenges related to use [67]. Based on literature, parental support has a positive influence over the digital literacy of adolescents, their awareness of online safety, and how to be responsible when using digital technologies [68,69].

Moreover, parents actively participating in the activities of their children relating to technology could easily develop an open and supportive ambiance and environment that boosts their exploration, learning, and creative technology use [69,70]. As a result, parental support and guidance for Generation Z individuals would lead to the latter's technology adoption, after which benefits can be reaped for many life aspects.

In the integrated account, parental support operates as family social capital that augments coping capacity—it provides reassurance, informal training, and normative backing that help students translate utility beliefs into enacted use in uncertainty-laden, immersive settings.

Hence, this study proposes the following hypothesis for testing;

H5. *Parental support is positively associated with metaverse adoption among university Gen Z.*

3.6. Technological aptitude

The technological affinity and proficiency of users is known as technological aptitude, and it has the potential to influence users' integration and use of the metaverse [71].

In addition, technological aptitude has the potential to influence Generation Z in their engagement with digital technologies [72], and considering the generation is referred to as digital natives, who were reared surrounded by technologies, this makes them capable and comfortable in using digital technologies and platforms [72,73]. Based on research, individuals with technological aptitude have a higher likelihood to use and adopt technologies, interact through digital platforms and make use of their advantages [73,74].

Based on the role of technological affinity and aptitude in forming the interactions with digital technologies among Generation Z, it is proposed that individuals with high technological affinity and aptitude are more likely to show a higher inclination towards exploring and leveraging digital platforms, which would enhance their metaverse engagement and use. In our integrated account, technological aptitude functions as a capability enabler that supports coping capacity: skillfulness reduces perceived difficulty and uncertainty in immersive environments, helping students translate perceived utility into enacted metaverse use. Thus, this study proposes that;

H6. *Technological aptitude is positively associated with metaverse adoption among university Gen Z.*

3.7. Curiosity and exploration

This is considered the Generation Z's inclination to explore, be curious, and be open to new experiences, which are the main drivers of their metaverse engagement [75,76].

More importantly, curiosity and exploration have a hand in forming the metaverse engagement and willingness among Generation Z and their exploration of new digital experiences. Such curiosity is innate in an individual, driving their seeking of knowledge, discovery of new information, and exploration of new opportunities. Openness and exploration show that the individual is receptive to new experiences, ideas, and perspectives [77,78].

Among the generations, Generation Z is naturally more curious and open to new emerging technologies and digital platforms, and are proactive in seeking out new digital experiences like virtual and augmented reality, owing to their innate will for discovery and engagement [77,79].

Based on the literature, individuals who are highly curious have a higher likelihood to engage in information-seeking behaviors, taking part in online communities, and be more inclined towards experimenting with novel technologies. In the same way, individuals who are more open to exploring have a tendency to reflect higher digital literacy, adaptability, and technological know-how coupled with the drive to explore various online environments [78,79].

Hence, owing to the role of CE in the digital engagement promotion among Generation Z, it is proposed that individuals who are highly curious and open to exploring, will reflect a higher inclination towards exploring and immersing themselves in the metaverse. In our integrated account, CE functions as a motivational route that helps students engage with uncertainty—supporting discovery and persistence—and works alongside utility appraisals (e.g., perceived usefulness) and coping capacity (e.g., self-efficacy; facilitating conditions). Thus, it is hypothesized that;

H7. *Curiosity and exploration are positively associated with metaverse adoption among university Gen Z.*

3.8. Motivation for learning

For Generation Z, their intrinsic motivation and desire to learn and feed their personal growth may drive their metaverse engagement for educational and developmental purposes [80,81]. Motivation for learning refers to the internal drive or external influence that encourages students to begin, sustain, and succeed in learning tasks.

This variable contributes in shaping the engagement of Generation Z with the metaverse as well as their desire to follow through with educational opportunities and self-development using digital means. Learning motivation is the internal drive and desire towards the acquisition of knowledge, development of skills, and engagement for knowledge learning [82–84].

Generation Z is characterized by ambitious individuals who are all for personal growth and who try their best to leverage educational opportunities in order to meet their interests and aspirations. They place value on learning and are known to be interactive and engaging when provided with opportunities to develop their skills and their personal advancement. They are proactive in using digital platforms and virtual environments, offering educational resources, online courses, and collaborative learning [83].

Literature along this line indicates that individuals who are greatly motivated towards learning have a higher likelihood to engage in self-directed learning, adopt new technologies for such purpose and reflect higher achievement when it comes to education [82,83,85]. In addition, individuals who are fully committed to their personal growth show higher levels of resilience, adaptability, and unique approaches towards the acquisition of the required knowledge and skills [83,84].

For university Gen Z, strong learning motivation aligns metaverse use with purposeful academic and developmental goals, helping sustain engagement. In this way, motivation supports the translation of perceived usefulness into actual use, even when novel features or uncertainty are present, and thus, this study hypothesizes that;

H8. *Motivation for learning is positively associated with metaverse adoption among university Gen Z.*

3.9. Facilitating conditions

According to Venkatesh et al. [46], facilitating conditions refer to the individual's belief that an organizational and technical infrastructure exists to support the system use. Metaverse use naturally requires distinct abilities, materials, and technical infrastructure; in other words, its use calls for the support of a specific and complex technical infrastructure [58]. Consequently, it can be affirmed that achieving successful metaverse adoption requires the provision of adequate resources and technical support to aid Generation Z in utilizing such innovations. As emphasized by Alam et al. [86] and Albanna et al. [43], facilitating conditions play a pivotal role in influencing individuals' adoption and utilization of technologies [42]. In other words, the facilitating conditions have a considerable influence over the adoption of innovative technologies [57,87]. Consequently, it can be predicted that Generation Z has a higher likelihood of using metaverse products if they have available technological infrastructure, resources, and expertise. In this study, we conceptualize facilitating conditions as response efficacy in practice (access, training, safeguards, compatibility), i.e., the safety and support infrastructure embedded in use, not only pre-use availability. Thus, we hypothesize that;

H9. *Facilitating conditions are positively associated with metaverse adoption among university Gen Z.*

3.10. Metaverse adoption and its impacts

The proposed model measures the level to which individuals achieve metaverse adoption successfully, and thus, this concerns the level of involvement, frequency of use, and active participation in the virtual environment. In relation to this, the model examines the effects of metaverse adoption on the individuals, society, and ethical considerations, based on their potential benefits (enhanced learning experiences and personal growth) and potential challenges and ethical implications.

In line with such integration, it proposed that self-efficacy and facilitating conditions are coping-capacity levers that go hand in hand with performance, effort, and social influence of UTAUT, and that with curiosity/exploration functioning as drivers of uncertainty management among the youth adoption. Such framing steers clear of being a sole additive checklist but rather one that is consistent with every construct in a context that is characterized by immersion and risk-awareness [42, 46,48,49,52].

Through the investigation of such factors and their connection to metaverse adoption, it is the objective of this paper to highlight the drivers and outcomes of metaverse engagement in a comprehensive manner. The findings are expected to extend current literature in providing knowledge and information for educational stakeholders, policy makers and practitioners who are looking towards using metaverse optimally for the purpose of individual growth, social connections and ethical implications.

On the level of the individual, the metaverse paves the way for Generation Z for opportunities to express themselves, develop their personal growth, and develop their skills. They can make use of the metaverse to create and customize their virtual identities, explore various virtual environments, and engage in immersive experiences that promote their self-discovery and innovation [24]. Generation Z can use the metaverse to extend their horizons, achieve digital literacy and develop critical skills needed for this era characterized by digital technologies. Nevertheless, when compared with other immersive and interactive technologies, the metaverse could lead to considerable adverse outcomes if not managed and controlled appropriately [27], and therefore, this study proposes that;

H10. *Metaverse adoption is positively associated with perceived individual impacts among university Gen Z.*

The metaverse transforms the connection, collaboration, and communication of Generation Z on a platform for virtual social interactions, and it enables them to interact with their friends, peers, and similarly minded communities throughout geographical boundaries [88, 89]. Generation Z can bask in the sense of belongingness and shared experiences through the metaverse, which would enable them to form new friendships, communities, and professional connections [90,91]. Nevertheless, the question arises as to the nature of virtual relationships, the ambiguous line between virtual and physical worlds, and the effect on the actual social interactions in real life [24,92].

Therefore, this study proposes the following hypothesis;

H11. *Metaverse adoption is positively associated with perceived social impacts among university Gen Z.*

Moving on to the field of ethics, the metaverse offers opportunities as well as challenges for Generation Z in that, on one hand, it provides space that the generation can exploit to promote diversity, inclusion, and social justice [24,30]. It allows questioning societal norms, identity authentication, and advocating for causes that interest them [20,25]. On the other hand, ethical concerns crop up relating to data privacy and security, with the accompanying potential for exploitation/addiction to the metaverse [24,30]. Such ethical complexities will be faced by Generation Z, which is why there is a need for an ethical framework to govern the metaverse [93,94]. Thus, this study hypothesizes that;

H12. *Metaverse adoption is positively associated with perceived ethical impacts among university Gen Z.*

Table 2 shows the whole set of hypotheses prepared by a study

The classical moderators of UTAUT, namely, age, gender, and experience is excluded from the main model owing to the narrow and relatively homogenous target comprising Gen-Z University goers. This limits the theoretical age and experience variance, and thus, parsimony is prioritized in the specifications of the structural model [9,46,53,54]. However, owing to the notable gender imbalance found in the Saudi sample, an analytical solution is conducted by estimating the models controlling for gender in the sub-sample of Saudi students (reported with results) while maintaining the theory-driven and comparable nature of the core model.

Table 2
The study formulated hypothesis.

No.	Hypothesis
H1	Social influence is positively associated with metaverse adoption among university Generation Z.
H2	Performance expectancy is positively associated with metaverse adoption among university Generation Z.
H3	Effort expectancy is positively associated with metaverse adoption among university Generation Z.
H4	Self-efficacy is positively associated with metaverse adoption among university Generation Z.
H5	Parental support is positively associated with metaverse adoption among university Generation Z.
H6	Technological aptitude is positively associated with metaverse adoption among university Generation Z.
H7	Curiosity and exploration are positively associated with metaverse adoption among university Generation Z.
H8	Motivation for learning is positively associated with metaverse adoption among university Generation Z.
H9	Facilitating conditions are positively associated with metaverse adoption among university Generation Z.
H10	Metaverse adoption is positively associated with perceived individual impacts among university Generation Z.
H11	Metaverse adoption is positively associated with perceived social impacts among university Generation Z.
H12	Metaverse adoption is positively associated with perceived ethical impacts among university Generation Z.

4. Methodology

This cross-sectional, observational study identifies statistical associations and does not support causal inference. The study methodology is explained and presented in this section.

4.1. Sampling and data collection

This exploratory study mainly aims to shed light on metaverse use among Generation Z university goers and the use's perceived effects. Generation Z refers to individuals born between 1997 and 2012 – a cohort notable for their high digital proficiency owing to their continuous exposure to emerging technologies and platforms [42,95,96].

Accordingly, this study adopts a quantitative, deductive design for hypothesis testing and examining the constructs' relationships in the context of Malaysia and Saudi Arabia [97]. The selection of the two contexts enables a cross-cultural comparison of Gen-Z university goers who are metaverse users. Such a comparison reflects differences in terms of demographics, socio-economic conditions, technological infrastructure, and attitudes towards technology. The design enables investigating the way Gen Z interacts with the metaverse throughout unique cultural contexts, and the way contextual factors may contribute to their adoption and their perceived individual, social, and ethical effects.

To begin with, the official statistics from Malaysia revealed the extensive use of technology among Generation Z, which constitutes a significant proportion of the population and originates from different ethnicities [98]. Current analyses indicated high intention towards advanced technologies adoption, with the inclusion of metaverse-related solutions, with the expectancy of macroeconomic contributions from AI in the coming decade [42]. Meanwhile, in the Saudi context, AI and digital innovation have been stressed on by national strategies – the Kingdom has a significant population of youth, and the projected economic gains from AI adoption by 2030 are astronomical [99]. These contexts lay down the basis for investigating metaverse use among Gen Z in two contexts that differ in cultural and developmental trajectories.

UTAUT underpinned studies showed a recurring limitation, which is the focus on one cultural or national setting [42,100]. This gap is addressed in the present study by undertaking a cross-cultural examination of Malaysia and Saudi Arabia to assess if, and the way major determinants of metaverse use and perceived effects differ from one context to the next.

Thus, the obtained sample through the five-case-per-indicator rule of thumb numbered 325, and this was used to validate the proposed model [101], with data gathered using a cross-sectional online survey using Google Forms. This study targeted undergraduate and postgraduate students from the fields of social sciences, engineering, business/management, and computer science at the Saudi public universities in Riyadh. As for the Malaysian population, the target was university students in Malaysian public universities in KL and Selangor, to which survey copies were distributed via institutional channels. The number of copies distributed was as follows: 1000 for Malaysian students and 1500 for Saudi students, from which 620 responses were deemed valid – 300 were retrieved from Malaysian universities and 320 from Saudi universities, indicating a 24.8% rate of response.

Owing to the lack of a comprehensive sampling frame for metaverse users, the non-probability purposive sampling was employed with the eligibility conditions being that the respondents are metaverse users confirmed through initial screening item [23,102], and as such, the sample reflects university-going Gen Z who had experience using metaverse for their academic tasks and/or entertainment purposes.

Aligned with the study design and sampling method adopted, the findings targeted university-enrolled Gen Z using a platform-agnostic measurement strategy that is generalizable to all Generation Z or to the whole employed youth population. The adopted purposive online sampling frame reflects interpretable estimates, particularly for similar student populations and institutional samples. In this regard, cross-cultural interpretation is honed to the general mechanisms of family support, institutional resources, and uncertainty management as opposed to country-level generalizations that are not within the surveyed sample.

4.2. Sample characteristics

As mentioned, there were 300 valid questionnaires from the Malaysian universities, with female students constituting the majority of the responses (56.6%), while the remaining were male responses (43.33%). The students' ages ranged from 17 to 25 years old, with an average of 20 years. With regards to their academic level, the majority of the Malaysian students (66.33%) were at the bachelor level, and most of them had less than 3 years of metaverse (61.67%), with the remaining 38.33% having over 3 years of metaverse experience.

As for the Saudi students, 320 valid questionnaires were considered valid and thus analyzed, and the results showed that the majority of the responses came from male students (62.50%), with the remaining 37.50% from female students. Their ages ranged from 16 to 25 years, with an average of 19 years. The majority were at the bachelor's level (75.94%) with 24.06% in postgraduate level. The majority of the Saudi students (55.31%) had less than 3 years of metaverse experience, with 44.69% having over 3 years of metaverse experience. Notably, all participants from both countries' universities had experience in using metaverse devices, like reality headsets, augmented reality glasses, and other immersive technologies that enable them to engage in the virtual realm, participate in social communities within it, and interact with the digital content. Metaverse devices include VR headsets (Oculus Quest), AR glasses (Microsoft HoloLens), and other platforms that bring about the virtual experiences of users. Having established that all the respondents were active metaverse device users ensured that the focus of the examination is on their experiences, perceptions, and the related impacts of the immersive technologies. Fig. 2 shows the sample characteristics of Saudi and Malaysian students.

4.3. Measurements

The study used 65 items from the literature for the purpose of measuring the different variables of the proposed model (i.e. independent and dependent variables). After constructing the survey based on previous studies, it was thereafter validated for non-existent ambiguities in the items, with the initial instrument developed in the English language and translated into both Bahasa and Arabic prior to dissemination as suggested by Brislin [103]. The survey employed scales that were reflected in the statements gauged on a five-point Likert scale and ranged from strongly disagree (1) to strongly agree (5). The full-scale items of the survey are attached in the study appendix (Appendix A). Prior to the study, the participants were informed that data culled from their responses would be kept confidential and the results would be used for the sole purpose of the study. In Table 3, the values of Cronbach's alpha, mean, and standard deviation for each variable are presented. The constructs' means in both groups exceeded 4.00, with Cronbach's alpha values higher than the 0.7 cut-off point, which established the internal reliability of the constructs [104,105].

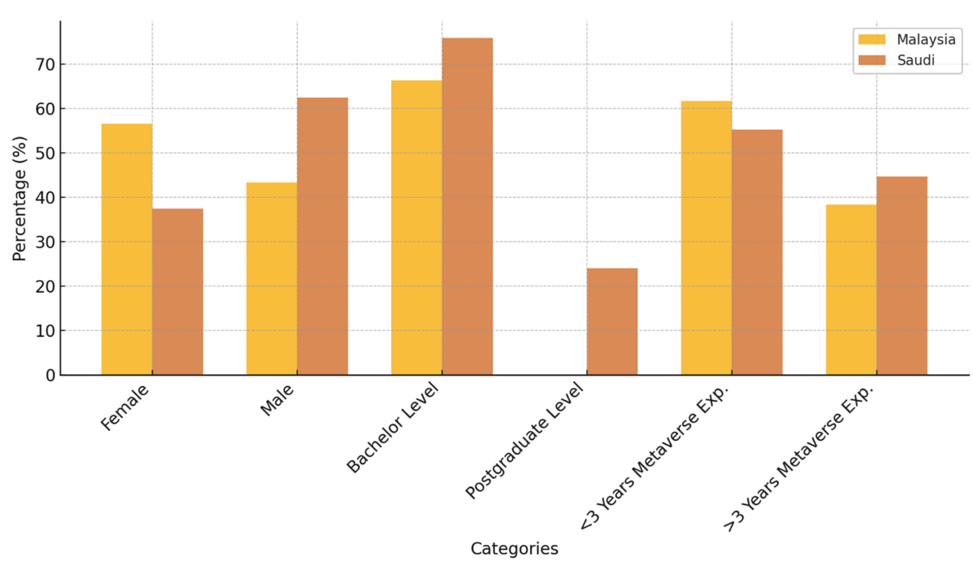

Fig. 2. Metaverse use by purpose and frequency among university Gen Z.

Table 3
Descriptive analysis of the constructs.

Constructs	Cronbach's Alpha	Mean	Std. Deviation
Social Influence	0.84	4.012	0.739
Performance Expectancy	0.85	4.167	0.755
Effort Expectancy	0.88	4.064	0.812
Self-Efficacy	0.86	4.646	0.890
Parental Support	0.83	4.055	0.754
Technological Aptitude	0.82	4.100	0.871
Curiosity and Exploration	0.91	4.044	1.034
Motivation for Learning	0.90	4.216	1.054
Facilitating Conditions	0.78	4.189	0.749
Metaverse Adoption	0.92	4.213	1.034
Individual Impacts	0.89	4.232	0.798
Social Impacts	0.84	4.122	0.876
Ethical Impacts	0.87	4.011	0.864

4.4. Data analysis

In this study, the proposed model was tested through PLS-SEM, a variance-based method, rather than a covariance-based one (CB-SEM), owing to several reasons. First, this is an exploratory study with the expected measures and relationships in the model that is proposed and newly examined or being insufficiently examined in literature [106]. Second, testing predictive models is likely more appropriate with the variance-based method in PLS as being mentioned by Hair Jr et al. [106]. Third, PLS-SEM has the ability of handling complicated research models that consist of several constructs and indicators [106]. Thus, PLS-SEM was used in analyzing the quantitative collected data by this study.

When there's a comparative study as in this study which involves a comparison between two countries, researchers are advised to use the PLS multi-group analysis (PLS-MGA). In such method, the statistical disparities in the path coefficients of the structural model for each of the examined nations should be assessed [42]. Specifically, PLS-MGA is a non-parametric method that was introduced to overcome parametric tests issues that crop up in CB-SEM [37,107]. The study also utilized the measurement invariance of composite models (MICOM) to examine the prerequisites for the multi-group analysis.

5. Findings

Under this section, the study findings obtained from the analysis are presented including analysis details and the process of validating the proposed model.

5.1. Common method bias

Podsakoff et al. [108] emphasized the concern of survey validity, citing a potential threat known as common method bias. To address this, Harman's single-factor test was employed as a means of resolution. The study incorporated this test and the outcomes revealed that none of the factors accounted for more than 51.5% of the total variance. This result indicates the absence of common method bias, aligning with Podsakoff et al. [108]. Kock [109] full collinearity test was also used to establish non-issue of common method bias, where all the variance inflation factors displayed values from 1.940 to 2.699 for Malaysian students, and 1.763 to 2.380 for the Saudi students, all under 3.3 (threshold value) and thus common method bias did not exist.

5.2. Measurement model assessment

Measurement model tests has been done before the validation of the proposed model and the testing of the formulated hypotheses. The measurement model was tested for construct reliability, discriminant validity and convergent validity. Using the Cronbach's Alpha (CA), construct reliability was tested first through the composite reliability (CR) as suggested by past studies [105,106]. No issues appeared in CR, with the values exceeding the 0.70 cut-off value in the two datasets. Moreover, factor loadings and the value of average variance extracted (AVE) were obtained for assessing the model's convergent validity and based on the values presented in Table 4. The items loadings on their respective constructs exceeding 0.60, with the AVE values higher than the recommended level of 0.50, in the two data sets, achieving past assumptions [105,106]. The obtained results supported a good level of convergent validity. Added to this, the Fornell-Larcker criterion was applied for assessing discriminant validity of both data sets [105,106]. The squared AVE of each construct in both samples exceeded the highest correlation with any other construct, indicating no discriminant validity issues in the two datasets.

5.3. Structural model assessment

Under this assessment phase, each sample was analyzed individually in the structural model, involving the testing of the collinearity issues. The results of which showed that VIF values of the constructs varied from 1.251–2.928 for the Malaysian students, and from 1.000–3.240 for the Saudi students. These indication of the satisfaction level of VIF values of independent variables in their dependent variables. Following this, the path coefficients were calculated using a bootstrap resampling technique, which involved 5000 resamples. This process generated t-values that ascertain the significance of the connections between the latent variables and their respective p-values. The proposed twelve paths (H1 to H12) of the structural model were evaluated, and the outcomes are presented in Table 5 and Fig. 3 for each respective sample.

As suggested by prior research [106,110], the investigation assessed the extent of variance accounted for in the dependent variables using R2 values. These values serve as an indicator of the predictive capability of the structural model. The sample from the Malaysian students showed that nine independent variables managed to explain 50.8% of the metaverse adoption variance, while the latter explained 45.7% of the individual impacts variance, 56.3% of the social impacts variance and 36.8% of the ethical impacts variance. On a similar note, the Saudi students showed that the nine independent variables explained 58.6% of the metaverse adoption, while the adoption explained 35.7% of the individual impacts 41.2% of the social impacts and finally, 46.5% of the ethical impacts.

Subsequent to the aforementioned step, the computation of f2 (effect sizes) followed. This metric quantifies the extent to which the variances in the dependent variables are elucidated by the independent variables. In this step, Cohen [110] rule of thumb was followed which states that f2 of 0.02 is small, 0.15 is medium and 0.35 is large. For both samples, the f2 values are tabulated in Table 5. Finally, the blindfolding procedure was adopted for determining Q2 values, which were all higher than 0, supporting the proposed model's predictive relevance in light of the reflective endogenous latent variables.

5.4. Model fit

The study used the standardized root mean square residual (SRMR), d_ULS, d_G, Chi-Square and normed fit index (NFI) to determine the model fitness. Table 6 displays the values of model fit indices, reflecting the achievement of the model's configuration objectives (SRMR 〈 0.08 and NFI 〉 0.9), as advised by Henseler et al. [37]. This supports the fitness between the model and the data.

5.5. Measurement invariance (MICOM)

This step involves the comparison between the Malaysian and Saudi sample through MICOM [37,38], which entails the following three steps: Initially, the configuration for assessing invariance was established to ensure that the measurement model maintained a comparable fundamental factor structure across the two groups; Secondly, a compositional

Table 4
Measurement model assessment results.

Construct	Item	Malaysia			Saudi Arabia		
		Loadings	**CR**	**AVE**	**Loadings**	**CR**	**AVE**
Social Influence (SI)	SI1	0.815	0.909	0.668	0.853	0.933	0.734
	SI2	0.839			0.865		
	SI3	0.825			0.867		
	SI4	0.795			0.868		
	SI5	0.811			0.831		
Performance Expectancy (PE)	PE1	0.783	0.910	0.668	0.856	0.930	0.727
	PE2	0.829			0.901		
	PE3	0.811			0.869		
	PE4	0.830			0.805		
	PE5	0.833			0.829		
Effort Expectancy (EE)	EE1	0.853	0.922	0.702	0.830	0.931	0.729
	EE2	0.818			0.848		
	EE3	0.844			0.875		
	EE4	0.813			0.850		
	EE5	0.861			0.864		
Self-Efficacy (SE)	SE1	0.859	0.917	0.690	0.828	0.934	0.740
	SE2	0.887			0.885		
	SE3	0.895			0.853		
	SE4	0.764			0.853		
	SE5	0.735			0.879		
Parental Support (PS)	PS1	0.714	0.873	0.580	0.886	0.935	0.740
	PS2	0.706			0.869		
	PS3	0.830			0.893		
	PS4	0.750			0.851		
	PS5	0.799			0.811		
Technological Aptitude (TA)	TA1	0.863	0.936	0.745	0.884	0.937	0.749
	TA2	0.843			0.880		
	TA3	0.885			0.897		
	TA4	0.860			0.869		
	TA5	0.864			0.793		
Curiosity and Exploration (CA)	CA1	0.863	0.925	0.711	0.855	0.936	0.746
	CA2	0.829			0.848		
	CA3	0.863			0.892		
	CA4	0.820			0.855		
	CA5	0.841			0.868		
Motivation for Learning (ML)	ML1	0.818	0.927	0.716	0.842	0.928	0.721
	ML2	0.824			0.845		
	ML3	0.887			0.865		
	ML4	0.849			0.831		
	ML5	0.852			0.863		
Facilitating Conditions (FC)	FC1	0.872	0.930	0.728	0.850	0.928	0.721
	FC2	0.854			0.834		
	FC3	0.852			0.874		
	FC4	0.844			0.841		
	FC5	0.844			0.845		
Metaverse Adoption (MA)	MA1	0.872	0.939	0.755	0.765	0.923	0.707
	MA2	0.860			0.882		
	MA3	0.835			0.764		
	MA4	0.891			0.913		
	MA5	0.885			0.868		
Individual Impacts (IM)	IM1	0.806	0.899	0.641	0.727	0.905	0.655
	IM2	0.779			0.831		
	IM3	0.845			0.798		
	IM4	0.801			0.855		
	IM5	0.770			0.830		
Social Impacts (SM)	SM1	0.773	0.904	0.653	0.739	0.892	0.623
	SM2	0.858			0.800		
	SM3	0.836			0.827		
	SM4	0.772			0.836		
	SM5	0.799			0.739		
Ethical Impacts (EM)	EM1	0.777	0.916	0.687	0.774	0.906	0.658
	EM2	0.844			0.766		
	EM3	0.876			0.827		
	EM4	0.874			0.851		
	EM5	0.768			0.834		

invariance assessment was conducted to verify that the composite scores remained consistent across the groups; Thirdly, the equality of composite means, values, and variances was examined. Upon confirming configurational and compositional invariances, partial measurement invariance is established, explaining and facilitating the comparison between both sample groups in Malaysia and Saudi Arabia. The reliability of the measurement is ensured when partial measurement invariance is accomplished, and there is similarity in the mean values and variances of the composite variables within the two groups [42].

Following some previous works such as Al-Sharafi et al. [42], in the initial stage, configured invariance was met, as the entire dataset utilized the same indicators, data processing methods, and algorithmic

Table 5
Findings of the structural model assessment.

Hypo	Relationship	Malaysian Context							
		Std Beta	t-value	p-value	F^2	VIF	R^2	Q^2	Decision
H1	Social Influence (SI) → Metaverse Adoption	0.302	3.137	0.000	0.075	2.820	0.508	0.525	Supported
H2	Performance Expectancy (PE) → Metaverse Adoption (MA)	0.207	2.418	0.002	0.042	1.845			Supported
H3	Effort Expectancy (EE) → Metaverse Adoption (MA)	0.206	2.787	0.003	0.041	1.891			Supported
H4	Self-Efficacy (SE) → Metaverse Adoption (MA)	0.258	2.993	0.000	0.070	2.364			Supported
H5	Parental Support (PS) → Metaverse Adoption (MA)	0.394	5.773	0.000	0.248	1.740			Supported
H6	Technological Aptitude (TA) → Metaverse Adoption (MA)	0.284	4.408	0.000	0.108	2.928			Supported
H7	Curiosity and Exploration (CA) → Metaverse Adoption (MA)	0.081	1.400	0.163	0.006	1.448			Not Supported
H8	Motivation for Learning (ML) → Metaverse Adoption (MA)	0.270	3.361	0.000	0.091	2.431			Supported
H9	Facilitating Conditions (FC) → Metaverse Adoption (MA)	0.193	1.965	0.025	0.032	1.701			Supported
H10	Metaverse Adoption (MA) → Individual Impacts (IM)	0.199	2.277	0.000	0.128	1.251	0.457	0.443	Supported
H11	Metaverse Adoption (MA) → Social Impacts (SM)	0.294	3.413	0.000	0.115	1.630	0.563	0.571	Supported
H12	Metaverse Adoption (MA) → Ethical Impacts (EM)	0.267	2.479	0.000	0.089	1.367	0.368	0.385	Supported
Hypo	**Relationship**	**Saudi Context**							
		Std Beta	**t-value**	**p-value**	**F^2**	**VIF**	**R^2**	**Q^2**	**Decision**
H1	Social Influence (SI) → Metaverse Adoption	0.252	2.537	0.000	0.088	2.950	0.586	0.592	Supported
H2	Performance Expectancy (PE) → Metaverse Adoption (MA)	0.247	2.820	0.005	0.055	2.190			Supported
H3	Effort Expectancy (EE) → Metaverse Adoption (MA)	0.246	3.094	0.000	0.054	2.289			Supported
H4	Self-Efficacy (SE) → Metaverse Adoption (MA)	0.308	3.521	0.000	0.082	2.800			Supported
H5	Parental Support (PS) → Metaverse Adoption (MA)	- 0.044	1.238	0.075	0.012	1.000			Not Supported
H6	Technological Aptitude (TA) → Metaverse Adoption (MA)	0.234	2.752	0.021	0.142	1.100			Supported
H7	Curiosity and Exploration (CA) → Metaverse Adoption (MA)	0.321	3.954	0.000	0.123	3.420			Supported
H8	Motivation for Learning (ML) → Metaverse Adoption (MA)	0.320	3.918	0.000	0.122	3.400			Supported
H9	Facilitating Conditions (FC) → Metaverse Adoption (MA)	0.083	1.390	0.096	0.050	1.070			Not Supported
H10	Metaverse Adoption (MA) → Individual Impacts (IM)	0.249	2.620	0.000	0.060	2.500	0.537	0.543	Supported
H11	Metaverse Adoption (MA) → Social Impacts (SM)	0.241	2.156	0.015	0.155	1.000	0.412	0.418	Supported
H12	Metaverse Adoption (MA) → Ethical Impacts (EM)	0.317	3.080	0.000	0.095	2.800	0.465	0.471	Supported

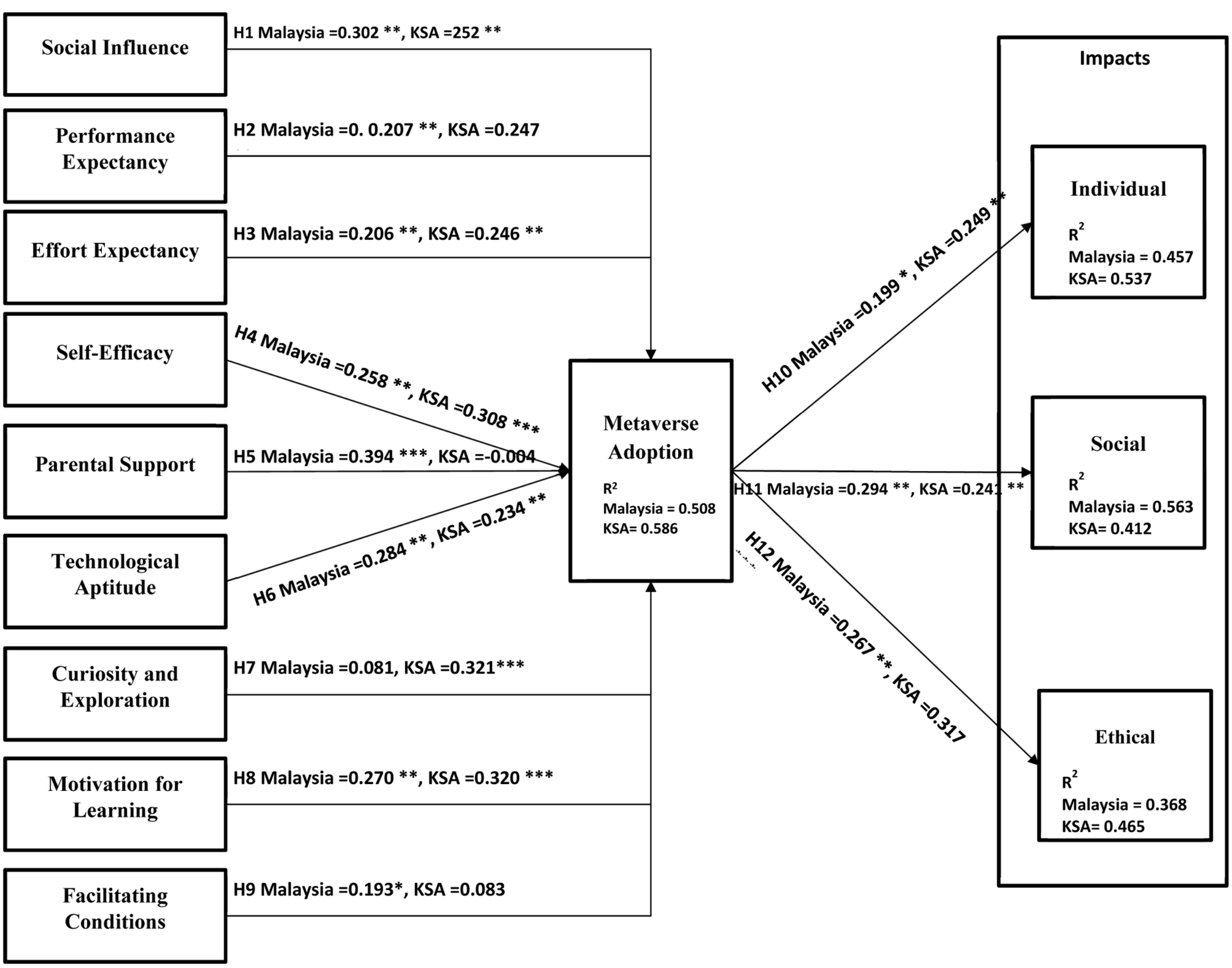

Fig. 3. The structural path samples from both countries' findings.

Table 6
Model fit indices.

	Saturated model	Estimated model
SRMR	0.035	0.040
d_ULS	0.610	0.721
d_G	0.432	0.449
Chi-Square	1200.000	1250.000
NFI	0.920	0.915

configuration. Put simply, the following second and third phases of the MICOM process centered on compositional invariance and achieving congruity in mean results (see Table 7). The MICOM results showed that the hypotheses can be tested as to the presence of significant differences between Generation Z in Malaysia and Saudi Arabia, in their use of metaverse.

5.6. Multi-group analysis

The differences in path coefficients between the two samples were assessed using PLS-MGA, as recommended by Henseler et al. [107]. This analysis facilitates a comparison between the bootstrap estimates of specific groups from each sample. If the path coefficients exhibit significant differences up to 0.05 or exceed 0.95 at a significance level of 5%, then it indicates a significant distinction in the path coefficients specific to the groups [36,37,107,111].

The outcomes derived from the PLS-MGA (see Table 8) demonstrated noteworthy variances between the Malaysian and Saudi participants concerning H5, H7, and H9. However, the samples for H1, H2, H3, H4, H6, H8, H10, H11, and H12 exhibited no discernible dissimilarities between the two groups. The analysis showed support for the differences between the metaverse use of Generation Z in Malaysia and Saudi Arabia, which contributes to the robustness of the research findings.

The path difference between Malaysia and Saudi Arabia is presented in Table 8, with one-tailed probabilities. The p-value (new) column showed three significantly differing paths at the level of 5%, all higher in Malaysia; in particular, H5 parental support → metaverse adoption ($\Delta\beta = 0.286$; $p = 0.001$), H7 curiosity/exploration → metaverse adoption ($\Delta\beta = 0.259$; $p = 0.005$), and H9 facilitating conditions → metaverse adoption ($\Delta\beta = 0.390$; $p = 0.000$). The remaining differences were not significant. Positive $\Delta\beta$ denotes that Malaysia is higher than Saudi Arabia.

5.7. Mediation effects of metaverse adoption

The mediation analysis was performed using bootstrapping with 5000 resamples, and the standardized indirect effects, confidence intervals (CIs), and significance levels (p-values) are reported in Table 9. A mediation effect was considered significant if the confidence interval (CI) did not include zero.

Table 7
Measurement invariance of composites (MICOM).

Constructs	Original Correlation	Correlation Permutation Mean	5.0%	Permutation p-Values
Social Influence	1.000	0.998	0.992	0.934
Performance Expectancy	0.998	0.999	0.995	0.970
Effort Expectancy	0.999	0.988	0.992	0.970
Self-Efficacy	0.998	0.967	0.997	0.966
Parental Support	1.000	0.969	0.995	0.450
Technological Aptitude	0.995	0.977	0.989	0.945
Curiosity and Exploration	1.000	0.958	0.994	0.099
Motivation for Learning	0.999	0.987	1.000	0.981
Facilitating Conditions	1.000	0.949	0.992	0.491
Metaverse Adoption	0.998	0.979	0.992	0.991
Individual Impacts	0.999	0.982	1.000	0.999
Social Impacts	1.000	0.998	0.998	0.922
Ethical Impacts	1.000	0.999	0.994	0.931

Table 8
PLS-MGA results.

	Structural paths	Path coefficients diff (Malaysia - KSA)	p-value original 1-tailed (Malaysia vs. KSA)	p-value new (Malaysia vs. KSA)
H1	Social Influence (SI) → Metaverse Adoption	−0.124	0.865	0.169
H2	Performance Expectancy (PE) → Metaverse Adoption (MA)	0.188	0.998	0.723
H3	Effort Expectancy (EE) → Metaverse Adoption (MA)	0.432	0.538	0.386
H4	Self-Efficacy (SE) → Metaverse Adoption (MA)	0.614	0.730	0.554
H5	Parental Support (PS) → Metaverse Adoption (MA)	0.286	0.049	0.001
H6	Technological Aptitude (TA) → Metaverse Adoption (MA)	0.461	0.613	0.467
H7	Curiosity and Exploration (CA) → Metaverse Adoption (MA)	0.259	0.047	0.005
H8	Motivation for Learning (ML) → Metaverse Adoption (MA)	0.638	0.396	0.312
H9	Facilitating Conditions (FC) → Metaverse Adoption (MA)	0.390	0.000	0.000
H10	Metaverse Adoption (MA) → Individual Impacts (IM)	−0.178	0.132	0.174
H11	Metaverse Adoption (MA) → Social Impacts (SM)	0.515	0.632	0.453
H12	Metaverse Adoption (MA) → Ethical Impacts (EM)	0.542	0.713	0.579

The results in Table 9 confirm that Metaverse Adoption significantly mediates the relationships between independent variables and the outcome impacts. Specifically, Social Influence, Performance Expectancy, Self-Efficacy, and Motivation for Learning exhibit strong indirect effects across all three impact categories (Individual, Social, and Ethical). The mediation analysis results indicate that Metaverse Adoption significantly mediates the relationship between multiple independent variables and Individual, Social, and Ethical Impacts.

Parent support is among the top mediators displaying the highest indirect impact throughout the three impact categories ($\beta = 0.078$ for Individual, $\beta = 0.110$ for Social, and $\beta = 0.102$ for Ethical Impact, all $p < 0.001$), highlighting the significant contribution of parental encouraged in metaverse use. Along a similar line of findings, social influence, technological aptitude, and motivation for learning displayed high mediation effects ($p < 0.01$), which means peer influence, digital skills, and learning motivation do have considerable role in the formation of metaverse-related outcomes. Indirect effects were also significant for performance expectancy, effort expectancy and self-efficacy ($p < 0.05$), which means that the confidence of the students in the usefulness and ease of use of metaverse impacts their general impacts. Contrastingly,

Table 9
Mediation effects of metaverse adoption.

Independent Variable	Indirect Effect on Individual Impact (β)	95% CI	p-value	Indirect Effect on Social Impact (β)	95% CI	p-value	Indirect Effect on Ethical Impact (β)	95% CI	p-value
Social Influence	0.060	(0.033, 0.094)	<0.01	0.089	(0.048, 0.135)	<0.01	0.081	(0.044, 0.124)	<0.01
Performance Expectancy	0.041	(0.019, 0.072)	<0.05	0.061	(0.030, 0.098)	<0.05	0.055	(0.028, 0.091)	<0.05
Effort Expectancy	0.041	(0.020, 0.067)	<0.05	0.059	(0.028, 0.095)	<0.05	0.053	(0.025, 0.085)	<0.05
Self-Efficacy	0.051	(0.027, 0.081)	<0.01	0.073	(0.042, 0.110)	<0.01	0.067	(0.038, 0.102)	<0.01
Parental Support	0.078	(0.045, 0.120)	<0.001	0.110	(0.065, 0.158)	<0.001	0.102	(0.061, 0.150)	<0.001
Technological Aptitude	0.057	(0.030, 0.088)	<0.01	0.082	(0.045, 0.120)	<0.01	0.076	(0.040, 0.115)	<0.01
Curiosity and Exploration	0.021	(0.009, 0.040)	0.07	0.031	(0.015, 0.056)	0.06	0.028	(0.012, 0.052)	0.08
Motivation for Learning	0.054	(0.032, 0.087)	<0.01	0.077	(0.044, 0.118)	<0.01	0.070	(0.040, 0.108)	<0.01
Facilitating Conditions	0.036	(0.018, 0.059)	<0.05	0.052	(0.028, 0.083)	<0.05	0.048	(0.025, 0.077)	<0.05

curiosity and exploration were found to have weaker and insignificant mediation effects ($p > 0.05$), which means that sole interest in examining the metaverse environment does not necessarily transform into meaningful benefits (individual, social or ethical). Overall, the findings support metaverse adoption as a key mechanism through which several factors have a hand in bringing about student engagement, digital learning competencies, and ethical awareness in immersive environments.

The inclusion of gender as a control in the Saudi sample had no effect on the direction or significance of substantive paths and thus, UTAUT x PMT pattern retained its stability.

6. Discussion

The results indicate that metaverse adoption among university Generation Z is shaped by a combination of utility appraisals and coping capacity in an immersive, uncertainty-laden environment. On the utility side, performance expectancy, effort expectancy, and social influence show stable positive associations with adoption in both national contexts. Students are more likely to engage when metaverse activities demonstrably advance task and learning goals, when interaction costs are low, and when credible others signal appropriateness and value [21, 46]. On the coping side, self-efficacy functions as a central lever: confidence to navigate immersive features and to manage privacy or identity exposure is associated with a greater propensity to use, consistent with the view that action under uncertainty depends on beliefs about capability and control [48,60]. Technological aptitude and motivation for learning further stabilise enactment by lowering perceived difficulty and aligning engagement with purposeful academic outcomes; these capabilities make it more feasible to realize the value signaled by utility beliefs [42,83]. Taken together, the evidence supports an integrated interpretation in which perceived usefulness is necessary but not sufficient; adoption is stronger when students also judge that they can act competently and safely in metaverse settings [46,48].

With respect to RQ2 (differences between Malaysia and Saudi Arabia), the multi-group analysis identifies three adoption pathways that differ significantly: the path from parental support to adoption (H5), the path from curiosity and exploration to adoption (H7), and the path from facilitating conditions to adoption (H9). Each of these effects is stronger in Malaysia. These contrasts arise against a shared baseline in which the principal utility and capability drivers—performance expectancy, effort expectancy, social influence, self-efficacy, technological aptitude, and learning motivation—operate in broadly similar ways across countries [37,42]. The comparatively stronger Malaysian effects for parental support and for facilitating conditions suggest that family social capital and the visibility of institutional supports function as contextual amplifiers that help convert value beliefs into enacted use. Parental reassurance and guidance augment coping by providing normative backing and informal training, while visible access, training, safeguards, and compatibility signal response efficacy in Protection Motivation Theory terms; that is, they indicate that effective protections and resources exist to act safely and productively [46,48,58]. The stronger curiosity and exploration pathway in Malaysia indicates that exploratory orientation is more readily transformed into sustained engagement where scaffolds and exemplars are salient (for example, onboarding, help-desks, safety controls, and integration with institutional systems). These findings do not contradict the shared utility core; rather, they imply that identical utility appraisals are more likely to be enacted where familial and institutional coping resources are visible and trusted.

In relation to RQ2 (unique comparative insights), two points merit emphasis. First, the Malaysian pattern implies that enactment resources matter: where familial encouragement and institutional infrastructure are salient and credible, the translation from utility beliefs to behavior is facilitated, so that utility and coping operate in tandem rather than in isolation. Second, the coupling of curiosity and exploration with facilitating conditions highlights a mechanism through which novelty seeking is channeled into guided discovery rather than sporadic experimentation; when supports are visible, exploration is more likely to yield persistent, purposeful use in immersive environments [46,48,58].

Turning to RQ3, adoption is positively associated with perceived individual, social, and ethical outcomes in both countries, and most antecedents influence these outcomes indirectly through adoption. In practical terms, realizing such downstream benefits suggests a two-step implementation strategy. First, secure adoption through task-level value and visible supports, including course-aligned activities, measurable learning gains, and accessible training, help, safeguards, and compatibility. Second, consolidate ethical competence through responsible-use scaffolds embedded in routine tasks, such as privacy-by-default settings, identity-management tools, and brief contextual prompts on safety and conduct [30,34,112–114]. Given the cross-sectional design, these relationships are interpreted as associations rather than causal effects, and inferential language is calibrated accordingly [97].

In synthesis, the findings align with an integrated UTAUT–PMT explanation of metaverse adoption in university settings. Utility appraisals—performance, effort, and social influence—remain central, but their translation into behavior depends on coping capacity, specifically self-efficacy and perceived response efficacy via facilitating conditions, supplemented by technological aptitude and motivation for learning [46,48,83]. Cross-country contrasts for parental support, curiosity and exploration, and facilitating conditions underscore the context-sensitivity of adoption mechanisms, varying with the salience of family social capital and the visibility of institutional supports [37,42]. Designing for task-level value alongside visible, trusted supports is therefore pivotal for converting perceived usefulness into enacted, responsible use and for unlocking individual, social, and ethical benefits.

The findings of this study highlight the critical role of metaverse adoption in shaping individual, social, and ethical impacts among Generation Z in Malaysia and Saudi Arabia. The results reinforce that key determinants such as social influence, self-efficacy, and motivation for learning play a significant role in encouraging metaverse adoption, while differences in parental support, curiosity, and facilitating conditions across both countries demonstrate the importance of cultural and contextual factors. Furthermore, the study confirms that metaverse adoption can drive positive individual growth, enhance social engagement, and improve ethical awareness, underscoring its transformative potential. By succinctly presenting these key findings, this study provides a clear and impactful understanding of how metaverse technologies influence digital interactions and engagement within different sociocultural settings.

The proposed model excluded classical UTAUT moderators, namely age, gender and experience as the sample is homogenous constituting Gen Z students and the focus is laid on parsimony – imbalance in gender in the Saudi sample is resolved through analytic controls and therefore, the findings' interpretation has to be conducted under such scope [46,53,54].

7. Study implications

This study contributes to both theory and practice and such contributions are detailed in the next sections.

7.1. Contributions to theory

This study contributes evidence concerning metaverse adoption among Gen Z university goers using a platform-agnostic design. Among the contributing findings, adoption is related with perceived individual, social and ethical outcomes, and this reveals the way use is related to downstream effects in the case of immersive situations. The second contributing finding is the comparison of the findings between the Malaysian and Saudi samples, revealing a shared core of determinants albeit three clear differences in terms of parental support, curiosity/exploration and facilitating conditions in different strength levels (per PLS-MGA). The differences highlight the roles of family support, exploratory orientation, and visible institutional resources in the formation of their use. The third contribution is the integration of UTAUT and PMT in one study, where self-efficacy and facilitating conditions function as coping-capacity levers with performance, effort, and social influence, youth-salient factors, namely parent support, technological aptitude, learning motivation and curiosity/exploration functioning to refine the way drivers lead to adoption. In this regard, the model managed to explain 58.6% of the variance in adoption in the Saudi sample and 50.8% in that of the Malaysian one. Lastly, the cross-country differences revealed that acceptance mechanisms are sensitive to context and that the comparison should investigate family mediation, uncertainty management, and institutional support.

The findings obtained through a platform-agnostic, focused on Gen-Z university goers, are not statistically generalizable to the entire Gen Z or to non-student populations. It is crucial for future studies to use probability-based, platform-stratified, and longitudinal approach for assessing platform-specific impact and to extend the validity and generalizability of findings.

7.2. Contributions to practice

The findings of this study serve as an actionable direction to adopt among different stakeholder levels including marketers, developers, and policymakers concerned with metaverse initiatives for Gen Z university goers.

The findings indicated the high strength of effects stemming from facilitating conditions, parental support, and curiosity/exploration, and this lays emphasis on visible support and guided exploration through which the following practices can be adopted – enable easy access through onboarding help, help-desk/virtual assistants, clear safety and privacy controls, campus integrations and the like, boost engagement of parents and student services using brief guides on safe, productive utility, and designing structured exploration through starter worlds, challenges, and learning paths for curiosity to be transformed to consistent usage. Lastly, compatibility needs to be established with other used systems for friction minimization.

Focus needs to be maintained on the shared core drivers, namely performance, effort, social influence, self-efficacy, technological aptitude, and learning motivation through the following practices; establish clear performance benefits in study, work use cases, and measurable outcomes, minimize effort using simple interfaces and task-based tutorials, make use of social proof, namely student champions and peer communities, and build skills to boost self-efficacy, and lastly, pave the way for ways connecting metaverse activities to tasks and future employability.

The positive relationship between adoption and perceived individual, social and ethical outcomes necessitate the following stakeholders' practices; provide support towards inclusive communities and sharing knowledge, building in privacy-by-default settings and security measures, provide tools to ensure identity management, and provide digital-literacy and ethics modules linked to actual platform tasks. All these practices establish the alignment of product experience with the study findings domains.

Another practice that can be adopted is to adapt marketing and engagement to local environmental patterns; for instance, in Malaysia, parental/institutional messaging can be paired with easy access and guided exploration and in KSA, emphasis on use, ease, peer endorsement and skills need to be made. Messaging platform-agnostic needs to be constant unless its features are directly linked to the determinants.

Ethical and responsible engagement of users' needs to be supported by universities and agencies by establishing clear guardrails of privacy, safety and conduct, providing micro-credentials to boost digital literacy and appropriating funds to support channels that abolish barriers to initial use.

Because the recommendations are targeted to student cohorts and platform-agnostic use, they need to be tweaked and adapted when used among non-student youth or other platforms.

8. Limitations

Similar to other studies, this work has limitations that qualify the interpretation of its findings. First, the study steered clear of differentiating between different metaverse types; consequently, platform heterogeneity is not modeled. Second, the design is cross-sectional; it captures users' experiences at a single point in time and cannot support causal claims. Third, the cross-country assessment does not incorporate variations in individual traits such as innovation propensity and technological apprehension, along with demographic attributes like age and educational background, which may mask meaningful heterogeneity.

Notably, there is limited generalizability owing to the non-probability purposive sampling used on university students in specific areas and the platform-agnostic instrument. This makes the findings ungeneralizable to all Generation Z in Malaysian and Saudi Arabian universities as well as to non-student samples [23]. These constraints should be borne in mind when interpreting cross-cultural differences and drawing practical implications.

9. Future works

Building on these limitations, future studies can (i) select specific metaverse types (e.g., Educational Classroom Metaverse, Sports and Entertainment Metaverse, Travel and Tourism Metaverse) to examine platform-specific dynamics; (ii) adopt longitudinal research designs rather than cross-sectional approaches to assess temporal change and strengthen causal inference; and (iii) include moderators capturing individual traits (e.g., innovation propensity, technological apprehension) and demographics (e.g., age, educational background).

Broader inference will also benefit from probability-based sampling and platform-stratified designs that include non-student Gen Z, as well as longitudinal approaches to extend validity and generalizability. Additionally, because metaverse ecosystems differ in features, governance, and user communities, drivers of adoption and user experiences may vary across platforms; consequently, the present findings should be interpreted as platform-agnostic patterns among university Gen Z, and future work should probe platform-specific effects.

10. Conclusion

This research managed to conduct a comprehensive analysis of the drivers of metaverse adoption and the adoption's impact on individual, society and ethics. The metaverse introduction as a convergence of virtual and augmented reality has led to the transformation of human lifestyle, and in relation to this, the study determines the critical factors (social influence, performance expectancy, effort expectancy, parental support and others) contribution to the metaverse adoption in both Saudi Arabia and Malaysian Generation Z. The investigation into these factors can enable the development of effective promotional strategies for adoption and highlight its effects on ethical, social and individual aspects in order to underline the opportunities for self-expression, skill development, immersive learning and ethical considerations (e.g., data privacy and security). The model was validated in its evaluation of metaverse adoption and use through the consideration of positive and negative impacts, whose results can guide policymakers, educators and researchers concerning the advantages, challenges and ethical implications of using metaverse. Finally, the research contributes to the promotion of metaverse responsible use, knowledge advancements in the topic and field and it presents invaluable information concerning the future development of metaverse.

Acknowledgement

Princess Nourah bint Abdulrahman University Researchers Supporting Project number (PNURSP2026R374), Princess Nourah bint Abdulrahman University, Riyadh, Saudi Arabia.

Data availability

The data will be available upon request.

CRediT authorship contribution statement

Norah Basheer Alotaibi: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

I declare that I have no conflicts of interest to disclose in connection with the submission of the manuscript titled 'Metaverse Adoption among University Generation Z in Malaysia and Saudi Arabia: A Cross-Cultural Analysis of Individual, Social and Ethical Impacts' to Computers and Education Open Journal. My involvement is solely driven by the pursuit of scholarly research and the commitment to producing unbiased and impartial findings.

Appendix A

Construct	Item	Question	Source
Social Influence (SI)	SI1	Peers who are important to me would think that I should use Metaverse	[21,43,44]
	SI2	Peers who influence my behavior would think that I should use Metaverse.	
	SI3	My superiors who influence my behavior would think that I should use Metaverse	
	SI4	My superiors to whom I report would think that I should use Metaverse	
	SI5	My family members or close friends who are important to me would think that I should use Metaverse	
Performance Expectancy (PE)	PE1	I find Metaverse useful in my daily life	[21,43,44]
	PE2	Using Metaverse increases my chances of achieving tasks that are important to me	
	PE3	Using Metaverse helps me accomplish my tasks more quickly	
	PE4	Using Metaverse increases my productivity	
	PE5	I believe that using Metaverse enhances my decision-making abilities and improves the quality of my work	
Effort Expectancy (EE)	EE1	Learning how to use Metaverse is easy for me	[21,43,44]
	EE2	My interaction with Metaverse is clear and understandable	
	EE3	I find Metaverse easy to use	
	EE4	It is easy for me to become skillful at using Metaverse	
	EE5	I believe that using Metaverse requires minimal effort and does not pose significant challenges or difficulties for me.	
Self-Efficacy (SE)	SE1	It would be easy for me to use Metaverse by myself	[21,43,44]
	SE2	I could adopt Metaverse even if there is no one around to tell me what to do as I go	
	SE3	I could adopt Metaverse if I could contact someone when I got stuck	
	SE4	I am confident in my ability to troubleshoot and overcome any difficulties or obstacles that may arise while using Metaverse.	
	SE5	I believe that I have the necessary skills and knowledge to effectively utilize Metaverse in my tasks and activities	
Parental Support (PS)	PS1	My parents are supportive of my decision to use Metaverse and encourage me to explore and utilize them.	[115,116]
	PS2	My parents provide guidance and assistance in learning about and using Metaverse	
	PS3	My parents actively engage with me in discussions about the benefits and responsible use of Metaverse	
	PS4	My parents trust my judgment when it comes to using Metaverse and respect my choices in this regard.	
	PS5	My parents provide the necessary resources and opportunities for me to access and experience Metaverse	
Technological Aptitude (TA)	TA1	I am naturally inclined towards understanding and using technology, including Metaverse	[117–119]
	TA2	I quickly grasp new technological concepts and can adapt to changes in technology.	
	TA3	I have a good understanding of the capabilities and limitations of Metaverse	
	TA4	I am comfortable exploring and experimenting with different Metaverse and features.	
	TA5	I have a strong ability to troubleshoot and solve technological issues related to Metaverse	

(*continued on next page*)

(*continued*)

Construct	Item	Question	Source
Curiosity and Exploration (CA)	CA1	I have a strong sense of curiosity and enjoy exploring new technologies, including Metaverse.	[120–123]
	CA2	I actively seek out information and resources to learn more about Metaverse and their applications	
	CA3	I enjoy experimenting with the features and functionalities of Metaverse to discover their full potential	
	CA4	I am open-minded and willing to try out different Metaverse to see how they can enhance my experiences and tasks	
	CA5	I am motivated to stay updated with the latest advancements in Metaverse and its practical uses	
Motivation for Learning (ML)	ML1	I am intrinsically motivated to learn and acquire new skills, including those related to Metaverse.	[124–126]
	ML2	I believe that learning about and using Metaverse can positively impact my personal and professional growth	
	ML3	I am driven by the desire to stay relevant in a technology-driven world and embrace the opportunities that Metaverse offers	
	ML4	I am motivated by the potential to improve my efficiency, productivity, and overall performance through the use of Metaverse	
	ML5	I find satisfaction in expanding my knowledge and competence in using Metaverse to accomplish tasks more effectively	
Facilitating Conditions (FC)	FC1	We have the resources necessary to use Metaverse	[21,43,44]
	FC2	Metaverse are compatible with the other technologies that I use	
	FC3	We can get help from others when we have difficulties using Metaverse	
	FC4	There are training programs, tutorials, or support materials available to help me enhance my skills in using Metaverse	
	FC5	I have access to reliable and stable internet connectivity, which is essential for using Metaverse effectively	
Metaverse Adoption (MA)	MA1	If I have access to the Metaverse, I plan to utilize it in my professional and personal engagements	[44,127,128]
	MA2	Given the opportunity, I anticipate that I will adopt the Metaverse for various applications	
	MA3	In my activities, I hope to utilize the Metaverse to its fullest extent if I have access to it	
	MA4	I would choose to use the Metaverse over other platforms or tools, even if they can perform the same tasks	
	MA5	The Metaverse is a critical aspect of my work and personal life, and I feel it is necessary to adopt it	
Individual Impacts (IM)	IM1	Metaverse increase personalization and customization.	[129–133]
	IM2	Metaverse increase access to information and knowledge	
	IM3	Metaverse enhances self-expression	
	IM4	having the potential to lead to digital addiction	
	IM5	having the potential to lead to isolation	
Social Impacts (SM)	SM1	Metaverse influences social interactions among its users	[34,52, 134–136]
	SM2	Metaverse impacted the formation of online communities	
	SM3	Metaverse affecting social norms	
	SM4	Metaverse promotes inclusivity in social interactions	
	SM5	Metaverse impacts the personal boundaries in virtual social interactions	
Ethical Impacts (EM)	EM1	The metaverse raises ethical concerns about data privacy	[30,112–114]
	EM2	The metaverse has the potential to contribute to digital inequality and access disparities	
	EM3	Ethical considerations of virtual identities and anonymity are integrated into the metaverse	
	EM4	The metaverse raises ethical concerns about security	
	EM5	Metaverse has ethical implications as it faces challenges in accurately distinguishing between virtual and real-world actions	

References

[1] Allam Z, Sharifi A, Bibri SE, Jones DS, Krogstie J. The metaverse as a virtual form of smart cities: opportunities and challenges for environmental, economic, and social sustainability in urban futures. Smart Cities 2022;5(3):771–801.

[2] Daradkeh M, Dawoud DW, Ismail S, Mansoor W. Perceptions, attitudes, and demographic influences on metaverse: a comprehensive investigation. Comput Hum Behav Rep 2024;15:100441.

[3] Di Pietro R, Cresci S. Metaverse: security and privacy issues. In: Proceedings of the third IEEE international conference on trust, privacy and security in intelligent systems and applications (TPS-ISA). IEEE; 2021. p. 281–8.

[4] Bongomin O, Gilibrays Ocen G, Oyondi Nganyi E, Musinguzi A, Omara T. Exponential disruptive technologies and the required skills of industry 4.0. J Eng 2020;2020:1–17.

[5] Subramanian M, Shanmuga Vadivel K, Hatamleh WA, Alnuaim AA, Abdelhady M, Satishkumar VE. The role of contemporary digital tools and technologies in Covid-19 crisis: an exploratory analysis. Expert Syst 2022;39(6):e12834.

[6] Ayling J, Chapman A. Putting AI ethics to work: are the tools fit for purpose? AI Ethics 2022;2(3):405–29.

[7] Kitchin R. Civil liberties or public health, or civil liberties and public health? Using surveillance technologies to tackle the spread of COVID-19. Space Polity 2020;24(3):362–81.

[8] Taylor S, Soneji S. Bioinformatics and the metaverse: are we ready? Front Bioinform 2022;2:50.

[9] Dwivedi YK, Hughes L, Baabdullah AM, Ribeiro-Navarrete S, Giannakis M, Al-Debei MM, Dennehy D, Metri B, Buhalis D, Cheung CM. Metaverse beyond the hype: multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy. Int J Inf Manag 2022;66:102542.

[10] Jafar RMS, Ahmad W, Sun Y. Unfolding the impacts of metaverse aspects on telepresence, product knowledge, and purchase intentions in the metaverse stores. Technol Soc 2023;74:102265.

[11] Jafar RMS, Zhu J, Crabbe MJC, Yue GXG, Yang Y. Unlocking the power of metaverse technology in tourism: enhancing experiences and perceptions about tourism destinations. Asia Pac J Tour Res 2024:1–14.

[12] Ma KW, Julianton RP, Chan XY, Chai YT, Mukred M, Leen MWE, Gumaei AH. A model for the adoption of artificial intelligence in inclusive education: an exploratory study of key factors and expert insights. J Inf Technol Educ Res 2025;24:027.

[13] Subaveerapandiyan A. Metaverse literacy among Gulf region librarians: understanding immersive technology adoption and perceptions. Bus Inf Rev 2025:02663821241310056.

[14] Belk R, Humayun M, Brouard M. Money, possessions, and ownership in the metaverse: NFTs, cryptocurrencies, Web3 and Wild Markets. J Bus Res 2022;153:198–205.

[15] Buhalis D, Karatay N. Mixed reality (MR) for generation Z in cultural heritage tourism towards metaverse. In: Proceedings of the information and communication technologies in tourism 2022: Enter 2022 eTourism conference. Springer; 2022. p. 16–27. January 11–14.

[16] Al-Adwan AS, Alsoud M, Li N, Majali TE, Smedley J, Habibi A. Unlocking future learning: exploring higher education students' intention to adopt meta-education. Heliyon 2024;10(9).

[17] Al-Adwan AS, Yaseen H, Alkkhwaldi AF, Jafar RMS, Fauzi MA, Abdullah A. Treasure hunting for brands: metaverse marketing gamification effects on purchase intention, WOM, and loyalty. J Glob Mark 2025:1–25.

[18] Charles DJ. The metaverse and the dawn of a new learning civilization: opportunity or threat?. Shaping the future of online learning: education in the metaverse. IGI Global; 2023. p. 37–56.

[19] Marikyan D, Papagiannidis S, Rana OF, Ranjan R. Blockchain: a business model innovation analysis. Digit Bus 2022;2(2):100033.

[20] Tlili A, Huang R, Shehata B, Liu D, Zhao J, Metwally AHS, Wang H, Denden M, Bozkurt A, Lee LH. Is Metaverse in education a blessing or a curse: a combined content and bibliometric analysis. Smart Learn Environ 2022;9(1):1–31.

[21] Venkatesh V, Thong JY, Xu X. Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. MIS Q 2012;36(1):157–78.

[22] Mukred M, Mokhtar UA, Hawash B, AlSalman H, Zohaib M, Abuzawayda YI. Exploring the potential of metaverse adoption in higher education: a diffusion of innovation model approach to enhancing student engagement. Sage Open 2025;15(3):21582440251363668.

[23] Sekaran U, Bougie R. Research methods for business: a skill building approach. John Wiley & Sons; 2016.

[24] Dwivedi YK, Hughes L, Wang Y, Alalwan AA, Ahn SJ, Balakrishnan J, Barta S, Belk R, Buhalis D, Dutot V. Metaverse marketing: how the metaverse will shape the future of consumer research and practice. Psychol Mark 2023;40(4):750–76.
[25] Park SM, Kim YG. A metaverse: taxonomy, components, applications, and open challenges. IEEE Access 2022;10:4209–51.
[26] Bibri SE, Allam Z. The Metaverse as a virtual form of data-driven smart urbanism: on post-pandemic governance through the prism of the logic of surveillance capitalism. Smart Cities 2022;5(2).
[27] Xi N, Chen J, Gama F, Riar M, Hamari J. The challenges of entering the metaverse: an experiment on the effect of extended reality on workload. Inf Syst Front 2023;25(2):659–80.
[28] Wu JG, Zhang D, Lee SM. Into the brave new metaverse: envisaging future language teaching and learning. IEEE Trans Learn Technol 2023.
[29] Chen X, Zou D, Xie H, Wang FL. Metaverse in education: contributors, cooperations, and research themes. IEEE Trans Learn Technol 2023.
[30] Kaddoura S, Al Husseiny F. The rising trend of Metaverse in education: challenges, opportunities, and ethical considerations. PeerJ Comput Sci 2023;9:e1252.
[31] Park H, Lim RE. Fashion and the metaverse: clarifying the domain and establishing a research agenda. J Retail Consum Serv 2023;74:103413.
[32] Gao W, Li L, Xue Y, Li Y, Zhang J. Design of security management model for communication networks in digital cultural consumption under Metaverse–The case of mobile game. Egypt Inform J 2023;24(2):303–11.
[33] Longo MC, Faraci R. Next-generation museum: a metaverse journey into the culture. Sinergie Ital J Manag 2023;41(1):147–76.
[34] Oh HJ, Kim J, Chang JJ, Park N, Lee S. Social benefits of living in the metaverse: the relationships among social presence, supportive interaction, social self-efficacy, and feelings of loneliness. Comput Hum Behav 2023;139:107498.
[35] Abbasi MS, Tarhini A, Elyas T, Shah F. Impact of individualism and collectivism over the individual's technology acceptance behaviour: a multi-group analysis between Pakistan and Turkey. J Enterp Inf Manag 2015;28(6):747–68.
[36] Deng X, Doll WJ, Al-Gahtani SS, Larsen TJ, Pearson JM, Raghunathan T. A cross-cultural analysis of the end-user computing satisfaction instrument: a multi-group invariance analysis. Inf Manag 2008;45(4):211–20.
[37] Henseler J, Hubona G, Ray PA. Using PLS path modeling in new technology research: updated guidelines. Ind Manag Data Syst 2016;116(1):2–20.
[38] Matthews L. Applying multigroup analysis in PLS-SEM: a step-by-step process. Partial least squares path modeling: Basic concepts, methodological issues and applications. Springer; 2017. p. 219–43.
[39] Srite M, Karahanna E. The role of espoused national cultural values in technology acceptance. MIS Q 2006:679–704.
[40] Jafar RMS, Jabeen M, Hussain S, Niu B, Sham R, Al-Adwan AS. Cyber shopping beyond boundaries: the metaverse revolution in e-commerce and consumer behavior. Hum Behav Emerg Technol 2025;2025(1):5559234.
[41] Brayshaw M, Gordon N, Kambili-Mzembe F, Al Jaber T. Why the educational metaverse is not all about virtual reality apps. In: Proceedings of the international conference on human-computer interaction. Springer; 2023. p. 22–32.
[42] Al-Sharafi MA, Al-Emran M, Arpaci I, Iahad NA, AlQudah AA, Iranmanesh M, Al-Qaysi N. Generation Z use of artificial intelligence products and its impact on environmental sustainability: a cross-cultural comparison. Comput Hum Behav 2023;143:107708.
[43] Albanna H, Alalwan AA, Al-Emran M. An integrated model for using social media applications in non-profit organizations. Int J Inf Manag 2022;63:102452.
[44] Mukred M, Yusof ZM, Alotaibi FM. Ensuring the productivity of higher learning institutions through electronic records management system (ERMS). IEEE Access 2019;7:97343–64.
[45] Rana NP, Slade E, Kitching S, Dwivedi YK. The IT way of loafing in class: extending the theory of planned behavior (TPB) to understand students' cyberslacking intentions. Comput Hum Behav 2019;101:114–23.
[46] Venkatesh V, Morris MG, Davis GB, Davis FD. User acceptance of information technology: toward a unified view. MIS Q 2003:425–78.
[47] Vimalkumar M, Sharma SK, Singh JB, Dwivedi YK. Okay google, what about my privacy?': user's privacy perceptions and acceptance of voice based digital assistants. Comput Hum Behav 2021;120:106763.
[48] Rogers RW. A protection motivation theory of fear appeals and attitude change1. J Psychol 1975;91(1):93–114.
[49] Akour IA, Al-Maroof RS, Alfaisal R, Salloum SA. A conceptual framework for determining metaverse adoption in higher institutions of gulf area: an empirical study using hybrid SEM-ANN approach. Comput Educ Artif Intell 2022;3:100052.
[50] Al-Emran M, Granić A, Al-Sharafi MA, Ameen N, Sarrab M. Examining the roles of students' beliefs and security concerns for using smartwatches in higher education. J Enterp Inf Manag 2021;34(4):1229–51.
[51] Cao G, Duan Y, Edwards JS, Dwivedi YK. Understanding managers' attitudes and behavioral intentions towards using artificial intelligence for organizational decision-making. Technovation 2021;106:102312.
[52] Zhang K. Metaverse and internet youth in China. In: Proceedings of the international conference on metaverse. Springer; 2022. p. 103–10.
[53] Dwivedi YK, Rana NP, Janssen M, Lal B, Williams MD, Clement M. An empirical validation of a unified model of electronic government adoption (UMEGA). Gov Inf Q 2017;34(2):211–30.
[54] Dwivedi YK, Rana NP, Jeyaraj A, Clement M, Williams MD. Re-examining the unified theory of acceptance and use of technology (UTAUT): towards a revised theoretical model. Inf Syst Front 2019;21:719–34.
[55] Bu F, Wang N, Jiang B, Jiang Q. Motivating information system engineers' acceptance of privacy by design in China: an extended UTAUT model. Int J Inf Manag 2021;60:102358.
[56] Patil P, Tamilmani K, Rana NP, Raghavan V. Understanding consumer adoption of mobile payment in India: extending Meta-UTAUT model with personal innovativeness, anxiety, trust, and grievance redressal. Int J Inf Manag 2020;54:102144.
[57] Arpaci I, Karatas K, Kusci I, Al-Emran M. Understanding the social sustainability of the Metaverse by integrating UTAUT2 and big five personality traits: a hybrid SEM-ANN approach. Technol Soc 2022;71:102120.
[58] Teng Z, Cai Y, Gao Y, Zhang X, Li X. Factors affecting learners' adoption of an educational metaverse platform: an empirical study based on an extended UTAUT model. Mob Inf Syst 2022;2022.
[59] Gil-Cordero E, Maldonado-López B, Ledesma-Chaves P, García-Guzmán A. Do small-and medium-sized companies intend to use the Metaverse as part of their strategy? A behavioral intention analysis. Int J Entrep Behav Res 2023.
[60] Bandura, A. 1986. Social foundations of thought and action. Englewood Cliffs, NJ 1986(23–28).
[61] He Y, Chen Q, Kitkuakul S. Regulatory focus and technology acceptance: perceived ease of use and usefulness as efficacy. Cogent Bus Manag 2018;5(1):1459006.
[62] Daragmeh A, Sági J, Zéman Z. Continuous intention to use e-wallet in the context of the covid-19 pandemic: integrating the health belief model (hbm) and technology continuous theory (tct). J Open Innov Technol Mark Complex 2021;7(2):132.
[63] Sebastian G. A study on metaverse awareness, cyber risks, and steps for increased adoption. Int J Secur Priv Pervasive Comput (IJSPPC) 2022;14(1):1–11.
[64] Kiger D, Herro D. Bring your own device: parental guidance (PG) suggested. TechTrends 2015;59:51–61.
[65] Li Z, Slavkova O, Gao Y. Role of digitalization, digital competence, and parental support on performance of sports education in low-income college students. Front Psychol 2022;13:979318.
[66] Eutsler L. Parents' mobile technology adoption influences on elementary children's use. Int J Inf Learn Technol 2018;35(1):29–42.
[67] Abdeen FH, Albiladi WS. Factors influencing the adoption of virtual reality (VR) technology among parents of individuals with ASD. Interact Learn Environ 2022:1–18.
[68] Correa T. Acquiring a new technology at home: a parent-child study about youths' influence on digital media adoption in a family. J Broadcast Electron Media 2016;60(1):123–39.
[69] Wald R, Piotrowski JT, Araujo T, van Oosten JM. Virtual assistants in the family home. Understanding parents' motivations to use virtual assistants with their child (dren). Comput Hum Behav 2023;139:107526.
[70] Lei L, Yu D, Zhou Y. Better educated children, better internet-connected elderly parents. Res Policy 2023;52(4):104743.
[71] Shatunova O, Sterz O. The structure of the person's technical aptitude and factors of its development. J Soc Stud Educ Res 2018;9(2):239–50.
[72] Sfodera F, Cain LN, Di Leo A. Is technology everywhere? Exploring Generation Z's perceptions of sustainable tourism in developing countries. Int Hosp Rev 2022 (ahead-of-print).
[73] Minarcin R. Ok boomer-the approaching DiZruption of legal education by generation Z. Quinnipiac Law Rev 2020;39:29.
[74] Goode JA, Fomby P, Mollborn S, Limburg A. Children's technology time in two US cohorts. Child Indic Res 2020;13(3):1107–32.
[75] Gómez-Maureira MA, Kniestedt I. Exploring video games that invoke curiosity. Entertain Comput 2019;32:100320.
[76] Rizzuto, R. 2022. The relationship of perceived learning and self-regulated learning of undergraduate students and the curiosity scores generated by packback.
[77] Hirsh-Pasek K, Zosh JM, Hadani HS, Golinkoff RM, Clark K, Donohue C, Wartella E. A whole new world: education meets the metaverse. Policy Brief 2022. Center for Universal Education at The Brookings Institution.
[78] Svensson J. Technology culture as youth oriented. Digital ageism. Routledge; 2023. p. 71–87.
[79] Bonime W. Superfuture: how global superminds can use immersive experiences to build a positive future. Massachusetts Institute of Technology; 2021.
[80] Donald JG. Motivation for higher-order learning. New directions for teaching and learning, 1999. Wiley; 1999. p. 27–35.
[81] Wæge K. Motivation for learning mathematics in terms of needs and goals. In: Proceedings of the CERME. 6; 2010. p. 84–93.
[82] Kim HS, Kim NY, Cha Y. Exploring the potential of Metaverse as a future learning platform for enhancing EFL learners' English proficiency. 영어학 2023;23:220–36.
[83] Park S, Min K, Kim S. Differences in learning motivation among Bartle's player types and measures for the delivery of sustainable gameful experiences. Sustainability 2021;13(16):9121.
[84] Sá MJ, Serpa S. Metaverse as a learning environment: some considerations. Sustainability 2023;15(3):2186.
[85] Shelley BP. The metaverse: a new avatar in medical educational ecosystems? Medknow 2022;10:147–53.
[86] Alam MZ, Hoque MR, Hu W, Barua Z. Factors influencing the adoption of mHealth services in a developing country: a patient-centric study. Int J Inf Manag 2020;50:128–43.
[87] Besson M, Gauttier S. Business meetings in the metaverse: stakeholder views evolve. J Bus Strategy 2023.
[88] Jin Y, Tiejun Z. The application of Metaverse XiRang game in the mixed teaching of art and Design in Colleges and Universities. Educ Inf Technol 2023:1–31.

[89] Okocha DO, James JN, Agaku T. Effects of digital technologies on academic performance of Nigerian adolescents. Strategies and opportunities for technology in the metaverse world. IGI Global; 2023. p. 247–62.
[90] Jun G. Virtual reality church as a new mission frontier in the metaverse: exploring theological controversies and missional potential of virtual reality church. Transformation 2020;37(4):297–305.
[91] López-Belmonte J, Pozo-Sánchez S, Lampropoulos G, Moreno-Guerrero AJ. Design and validation of a questionnaire for the evaluation of educational experiences in the metaverse in Spanish students (METAEDU). Heliyon 2022;8 (11).
[92] Dwivedi YK, Kshetri N, Hughes L, Rana NP, Baabdullah AM, Kar AK, Koohang A, Ribeiro-Navarrete S, Belei N, Balakrishnan J. Exploring the Darkverse: a multi-perspective analysis of the negative societal impacts of the metaverse. Inf Syst Front 2023:1–44.
[93] Bibri SE. The social shaping of the metaverse as an alternative to the imaginaries of data-driven smart Cities: a study in science, technology, and society. Smart Cities 2022;5(3):832–74.
[94] Chengoden R, Victor N, Huynh-The T, Yenduri G, Jhaveri RH, Alazab M, Bhattacharya S, Hegde P, Maddikunta PKR, Gadekallu TR. Metaverse for healthcare: a survey on potential applications, challenges and future directions. IEEE Access 2023.
[95] Dimock M. Defining generations: where Millennials end and Generation Z begins. Pew Res Cent 2019;17(1):1–7.
[96] Mason MC, Zamparo G, Marini A, Ameen N. Glued to your phone? Generation Z's smartphone addiction and online compulsive buying. Comput Hum Behav 2022; 136:107404.
[97] Creswell JW. A concise introduction to mixed methods research. SAGE Publications; 2014.
[98] Azman NN, Annathurai K, Alias SK, Majid MF, Alias MEH. The study of factors influencing online purchase intention in tiktok among generation Z. Universiti Malaysia Kelantan; 2023.
[99] Alattas K. Saudi Arabia corporate firms are hesitant to embrace artificial intelligence as of 2020 despite the numerous benefits. WSEAS Trans Syst Control 2023;18:38–46.
[100] Williams TV. An exploratory multiple case study of knowledge management systems in the United States financial sector. University of Phoenix; 2015.
[101] VanVoorhis CW, Morgan BL. Understanding power and rules of thumb for determining sample sizes. Tutor Quant Methods Psychol 2007;3(2):43–50.
[102] Tongco, M.D.C. 2007. Purposive sampling as a tool for informant selection.
[103] Brislin RW. Back-translation for cross-cultural research. J Cross Cult Psychol 1970;1(3):185–216.
[104] Hair JF, Ringle CM, Sarstedt M. Partial least squares structural equation modeling: rigorous applications, better results and higher acceptance. Long Range Plan 2013;46(1–2):1–12.
[105] Hair Jr JF, Hult GTM, Ringle C, Sarstedt M. A primer on partial least squares structural equation modeling (PLS-SEM). Sage Publications; 2016.
[106] Hair Jr JF, Hult GTM, Ringle CM, Sarstedt M. A primer on partial least squares structural equation modeling (PLS-SEM). Sage publications; 2021.
[107] Henseler J, Ringle CM, Sinkovics RR. The use of partial least squares path modeling in international marketing. Adv Int Mark (AIM) 2009;20:277–320.
[108] Podsakoff PM, MacKenzie SB, Lee JY, Podsakoff NP. Common method biases in behavioral research: a critical review of the literature and recommended remedies. J Appl Psychol 2003;88(5):879.
[109] Kock N. Common method bias in PLS-SEM: a full collinearity assessment approach. Int J e-Collab (IJEC) 2015;11(4):1–10.
[110] Cohen J. Statistical power analysis for the behavioral sciences. Routledge; 2013.
[111] Henseler J, Dijkstra TK, Sarstedt M, Ringle CM, Diamantopoulos A, Straub DW, Ketchen Jr DJ, Hair JF, Hult GTM, Calantone RJ. Common beliefs and reality about PLS: comments on Rönkkö and Evermann (2013). Organ Res Methods 2014;17(2):182–209.
[112] Anshari M, Syafrudin M, Fitriyani NL, Razzaq A. Ethical responsibility and sustainability (ERS) development in a metaverse business model. Sustainability 2022;14(23):15805.
[113] McStay A. The metaverse: surveillant physics, virtual realist governance, and the missing commons. Philos Technol 2023;36(1):13.
[114] Ning H, Wang H, Lin Y, Wang W, Dhelim S, Farha F, Ding J, Daneshmand M. A survey on the metaverse: the state-of-the-art, technologies, applications, and challenges. IEEE Internet Things J 2023.
[115] Delen E, Kaya F, Ritter NL, Sahin A. Understanding parents' perceptions of communication technology use. Int Online J Educ Sci 2015;7(4):22–36.
[116] Eutsler L, Antonenko PD, Dawson K. How parent perceptions relate to elementary children's portable technology use by gender and grade level. Comput Sch 2018; 35(4):302–23.
[117] Corrin L, Lockyer L, Bennett S. Technological diversity: an investigation of students' technology use in everyday life and academic study. Learn Media Technol 2010;35(4):387–401.
[118] Drinkard C. Technology integration in the middle school classroom: exploration of outcomes of behavior intentions, self-efficacy, and district expectations. Texas A&M Univ Commer 2022.
[119] Gromik N. Smartphone-based learning in the Japanese ESL classroom: a case study report. Cambridge Scholars Publishing; 2017.
[120] Magni M, Taylor MS, Venkatesh V. 'To play or not to play': a cross-temporal investigation using hedonic and instrumental perspectives to explain user intentions to explore a technology. Int J Hum Comput Stud 2010;68(9):572–88.
[121] Mandl MC. The relationship between adolescent parental attachment, curiosity, and coping with stress. Wayne State University; 2007.
[122] Mussel P. Epistemic curiosity and related constructs: lacking evidence of discriminant validity. Pers Individ Differ 2010;49(5):506–10.
[123] Silvia PJ, Kashdan TB. Interesting things and curious people: exploration and engagement as transient states and enduring strengths. Soc Personal Psychol Compass 2009;3(5):785–97.
[124] Al Yakin A, Seraj PMI. Impact of metaverse technology on student engagement and academic performance: the mediating role of learning motivation. Int J Comput Inf Manuf (IJCIM) 2023;3(1):10–8.
[125] Bulut İH, Delialioğlu Ö. An engagement and motivation model for online learning technologies. Interact Learn Environ 2022:1–18.
[126] Chandra RI, Boiliu NI. The metaverse's potential impacts on the God-centred life and togetherness of Indonesian Christians. Theol Viat 2022;46(1):157.
[127] Mukred M, Alotaibi FM, Yusof ZM, Mokhtar UA, Hawash B, Ahmed WA. Enterprise resource planning adoption model for well-informed decision in higher learning institutions. J Inf Sci 2022:01655515211019703.
[128] Mukred M, Yusof ZM, Alotaibi FM, Asma'Mokhtar U, Fauzi F. The key factors in adopting an electronic records management system (ERMS) in the educational sector: a UTAUT-based framework. IEEE Access 2019;7:35963–80.
[129] Iñiguez S. Part 4: vision–What does the future look like?. Philosophy inc. applying wisdom to everyday management. Springer; 2022. p. 93–120.
[130] Kovacova M, Machova V, Bennett D. Immersive extended reality technologies, data visualization tools, and customer behavior analytics in the metaverse commerce. J Self-Gov Manag Econ 2022;10(2):7–21.
[131] Mohamed ES, Naqishbandi TA, Veronese G. Metaverse!: possible potential opportunities and trends in E-healthcare and education. Int J E-Adopt (IJEA) 2022;15(2):1–21.
[132] Nie H. Virtual augmented reality advertising based on Metaverse platform. Inf Syst Econ 2023;4(4):77–81.
[133] Pérez RSM, Pérez TEL, Pérez RJM, López MVP. Technological innovation and education: a brief review of the literature. Ibero-Am J Educ Soc Res 2023;3(1): 25–30.
[134] Chao CH, Ting IH, Tseng YJ, Wang BW, Wang SH, Wang YQ. The study of DeFi in virtual community and financial supervision. In: Proceedings of the 9th multidisciplinary international social networks conference; 2022. p. 74–80.
[135] Sriram GK. A comprehensive survey on metaverse. Int Res J Mod Eng Technol 2022;4(2):772–5.
[136] Neethirajan S. (2023). The ethical frontier: navigating the metaverse in modern animal farming.