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Process Activities of a Neutrosophic-Based Smart Simulation Framework for Islamic Sacred Rituals

Nabil M. AbdelAziz[1,*], Mohamad S. AL-Thenyan[2], Nissreen El-Saber[3]
[1,*] nmabedelaziz@fci.zu.edu.eg; [2] memos320@hotmail.com; [3] nisreen.elsaber@miuegypt.edu.eg

[1,2,3] Information Systems Department, Faculty of Computers and Informatics, Zagazig University, Zagazig 44519, Egypt
[3] Software Engineering Department, Faculty of Information and Computers, Misr International University, Cairo 11785, Egypt

Abstract

This study investigates the application of Virtual Reality (VR) technologies in simulating sacred Islamic rituals and evaluates how specific features of VR programs influence the quality of the simulation experience. To enhance the accuracy of subjective evaluations and manage uncertainty in user responses, a neutrosophic-based framework is integrated into the assessment process. The research employs a quantitative methodology, utilizing a structured questionnaire administered to a sample of participants interested in immersive religious simulations. Four key characteristics of the VR program: user interface, visual and auditory components, ease of use, and content availability, were evaluated. The findings reveal a strong and statistically significant relationship between these features and perceived simulation quality, with a multiple correlation coefficient (R) of 0.929 and a coefficient of determination (R^2) of 0.863. By incorporating neutrosophic logic, the model captures the degrees of truth, indeterminacy, and falsity in users' evaluations, offering a richer and more flexible analysis. These results provide essential insights for designing spiritually meaningful and technically effective VR simulations, while setting a foundation for future neutrosophic-driven evaluations of religious technologies.

Keywords: Virtual Reality, Simulation of Islamic Rituals, User Interface, Visual and Auditory Aspects, Ease of Use, Neutrosophic Logic, Content Availability.

1. Introduction

The sacred Islamic rituals are an essential part of the religious and cultural practices of Muslims around the world. These rituals include various religious acts and ceremonies performed according to the teachings of Islam. Over the centuries, these rituals have undergone continuous development in the ways they are executed and organized. With the advancement of technology and the emergence of computer simulation, the intelligent processes of the sacred Islamic rituals have become a subject of interest and research. Computer simulation technology enables the realistic and interactive representation of actual processes without the need to perform the physical act. Computer simulation uses mathematical models that consider different variables and simulate the behavior of complex systems and processes [1].

In the context of sacred Islamic rituals, computer simulation techniques can be used to simulate and represent religious processes such as Hajj (pilgrimage), prayer, fasting, and Zakat (charitable giving), among others. Computer simulation in this context can have several potential benefits and applications, including providing a virtual environment that enables Muslims to better experience and understand the rituals, using simulation to educate individuals on the performance of rituals and clarify the steps to be followed, and enhancing the awareness and understanding of Islamic culture and traditions among non-Muslims by providing a better understanding of the rituals and traditions [2].

To address the inherent uncertainty, subjectivity, and variability in users' perceptions of immersive religious simulations, this study incorporates a neutrosophic-based analytical perspective. Neutrosophic logic, which extends classical and fuzzy logic, allows for the simultaneous representation of truth, indeterminacy, and falsity within a single evaluation. This is especially relevant when assessing spiritual experiences and human-computer interactions, where participant responses may not always be positive or negative. By applying a neutrosophic framework, the analysis captures the nuanced states of participants' perceptions—those who agree, those who disagree, and those who remain uncertain—offering a more flexible and robust evaluation of the VR application's effectiveness. This integration enhances the interpretability of the simulation results and positions the study within the evolving discourse on intelligent systems and decision-making under uncertainty.

Neutrosophic studies have emerged as a significant advancement in logic and decision-making, particularly in fields involving uncertainty, indeterminacy, and incomplete information. Introduced by [3], **Neutrosophic Logic** extends classical and fuzzy logics by incorporating three independent components: **truth (T), indeterminacy (I), and falsity (F)**, each ranging in value from 0 to 1. This triadic framework allows for a more nuanced representation of real-world scenarios, where ambiguity and partial knowledge are common. In recent years, neutrosophic logic has been applied in various domains including **artificial intelligence, engineering, medical diagnosis, and social sciences** [4]. Its ability

to process inconsistent and imprecise data makes it especially suitable for modeling **subjective user evaluations**, as it captures the degrees to which a response can be simultaneously true, indeterminate, and false. The flexibility and depth of neutrosophic logic thus provide a powerful tool for evaluating complex human-centric systems such as immersive simulations, where user perceptions often defy binary classifications. As such, neutrosophic studies continue to enrich computational models by offering a formalized yet adaptable framework for dealing with uncertainty in human experience.

Furthermore, computer simulation can contribute to improving the organization and management of sacred Islamic rituals. Modern techniques can be used to develop simulation- based management systems to help organize processes and improve their planning. For example, simulation can be used to determine the best times and locations for performing collective rituals, such as prayers in mosques or Hajj in sacred places. Additionally, computer simulation can contribute to analyzing the impacts of environmental and demographic changes on sacred Islamic rituals. Simulation models can be used to test the effects of changes in the number of participants or their geographical distribution on the organization and flow of the rituals, which can help in making better decisions regarding the management and improving the sustainability of the rituals in the face of future changes [5].

This research paper explores the potential of advanced computer simulation techniques for sacred Islamic rituals, aiming to identify their benefits and applications. It focuses on the essential activities and processes for a smart simulation framework designed to enhance participants' understanding and the effective organization and execution of these rituals. By developing and testing interactive simulation models, this work contributes to innovative tools that can improve the religious experience and Islamic knowledge.

2. Literature Review

The application of Virtual Reality (VR) in religious education has emerged as a significant field of research in recent years offering innovative methods to teach and simulate Islamic sacred rituals such as Hajj and Umrah. VR's immersive capabilities allow users to interact with digitally recreated sacred spaces, enhancing both cognitive understanding and emotional engagement. In this section, we highlight and analyze the published related studies in the field of utilizing VR technology in education and spiritual teachings applications.

In their study, [6] investigated the effectiveness of using VR to teach Hajj rituals. The experimental study found that participants trained via VR achieved significantly higher levels of procedural knowledge and self-confidence compared to those who received traditional text-based instructions. The study emphasized that VR enhances learning through experiential interaction, making it particularly suitable for rituals requiring sequential movements, such as Tawaf and Sa’i. The research demonstrated that AI-powered virtual guides could personalize the VR experience, offering dynamic, real-time feedback

to users. Their proposed hybrid VR/AI model showed potential to increase user engagement, learning efficiency, and correct procedural performance, particularly during complex ritual sequences.

More recently, [7] provided a comprehensive systematic review on the use and effect of VR, Augmented Reality (AR), and Mixed Reality (MR) in physical education. Their study aimed to explore the causal relationship between these advanced technologies and the improvement of students' motor and health competencies. It also examined their role in promoting optimal integration of kinetic and health educational content and in innovating effective motivational tools to enhance the overall learning experience in physical education. Employing a rigorous systematic review methodology following PRISMA guidelines, they selected 10 scholarly articles from major research databases such as Web of Science, Scopus, and Google Scholar. The qualitative analysis of these articles revealed a strong positive relationship between integrating VR, AR, and MR technologies and improved motor and health competencies, evidenced through interactive training and realistic simulations. The findings also indicated that these technologies significantly facilitate the optimal integration of kinetic and health educational content by providing immersive and interactive learning environments, making learning more engaging and comprehensible. Furthermore, the study confirmed that these technologies serve as effective motivational tools, increasing student engagement and interest in physical activities, thereby enhancing the overall educational experience in physical education.

Adding another perspective, [8] explored the impact of Virtual Reality (VR) tour experience on tourists' intention to visit, leveraging the media richness provided by this technology. Using a mixed-methods approach, the study utilized deductive theory to explore and confirm VR dimensions, then an inductive theory to model how VR presence influences tourist visit intention. The research directly measured the impact of VR presence on visit intention and assessed the mediating role of cognitive and conceptual variables such as destination perceptions and telepresence. The qualitative phase involved 30 semi-structured interviews with tourism experts, while the quantitative phase surveyed 300 respondents who watched VR tourism videos. Analyzing data through content analysis and PLS-SEM, the main results revealed that VR presence directly and indirectly influences tourist visit intention. Directly, the VR experience boosts tourists' desire to visit a destination. Indirectly, this effect is amplified by mediating variables: VR presence enhances users' telepresence in the destination, deepening positive perceptions, which in turn influences visit intention. The findings suggest significant managerial implications for improving tourist experience and increasing visit intention by leveraging high- quality VR content to create immersive experiences that evoke positive emotions and enhance destination perceptions, encouraging actual visits.

Furthermore [9] in their study titled "Smart Internet of Things in the Healthcare Sector," aimed to outline a comprehensive structure for smart IoT systems within healthcare. This research focused on identifying the core components, functions, and practical applications

of these systems. Employing a descriptive and analytical approach, the study gathered data from existing scientific literature and prior research. The independent variable, "smart Internet of Things," was measured across four dimensions: smart devices, communication network, database, and artificial intelligence algorithms. The findings revealed that a smart IoT healthcare system comprises smart devices (such as smartphones and wearables), a communication network for connectivity, a database for data storage, and AI algorithms for analysis and decision-making. The study highlighted diverse applications, including health monitoring (tracking vital signs and emergency cases), home care, telemedicine, and remote healthcare delivery. It concluded by recommending further development of smart IoT systems to meet evolving patient and healthcare provider needs.

Furthermore, [10] explored the potential of using VR and AR applications in virtual learning tours, particularly in the context of historical sites. Their study aimed to develop a theoretical and practical framework for VR/AR, focusing on building a cognitive bridge between digital culture and physical reality, and providing technological tools to support learning through immersive experiences. The research methodology involved creating a 3D model of the Arta bridge in Greece using 3D Max software, then applying it in VR and AR contexts. Technical and empirical evaluations were conducted by field specialists and experienced students. The findings showed that the virtual learning environment, utilizing VR/AR technologies, can be a highly effective educational tool, providing a rich and interactive learning experience that enhances understanding of historical sites and makes learning more engaging. The study recommended further research and application of these technologies in cultural and learning fields, emphasizing their growing role in enriching the future educational experience.

In the realm of specialized training, [11] focused on developing a VR lab for automotive service specialists to facilitate knowledge transfer and provide an innovative learning environment in the digital age. Their study aimed to transition from traditional knowledge transfer methods to online learning, especially in response to challenges posed by the COVID-19 pandemic. The research methodology involved analyzing educational documents and surveying 344 automotive service students. Standardized VR virtual labs were developed, along with work scenarios, lab functions, and user interface elements. The feasibility and educational efficiency of the application were reviewed through student questionnaires and expert evaluations. The main results demonstrated that the proposed VR lab offers significant advantages compared to traditional training courses, increasing the effectiveness of practical skills training and providing a more engaging and efficient learning experience. The findings also indicated that engineering and English language students achieved significantly better results when using these technologies, highlighting the potential for enhancing learning efficiency and bridging the gap between traditional knowledge transfer and digital transformation.

[12] In their study titled "The extent of the contribution of the use of smart devices in Hajj, Umrah and Visits," evaluated how smart devices improve the experience of pilgrims

and visitors in Saudi Arabia. This descriptive analytical study surveyed 400 individuals, focusing on cognitive awareness, usage rates, and attitudes towards smart applications. Findings indicated that most participants were aware of and frequently used smart apps, which significantly facilitated planning, mobility, accommodation, worship, and safety, leading to high satisfaction. The study recommended continuous development of smart services and increased awareness.

[2] conducted a systematic review titled "Applications and Challenges of Artificial Intelligence in Religious Tourism and Hospitality." Their study investigated AI applications, their benefits (personalized services, improved operations, cost reduction), and challenges (ethical concerns, privacy, bias, social acceptance) in this sector. By reviewing 43 studies, they confirmed AI's potential to enhance visitor experience and operational efficiency. However, they also highlighted the necessity of strict ethical guidelines and local community acceptance for successful AI implementation, recommending continued research, public-private collaboration, and awareness campaigns.

Furthermore, [13] conducted a comprehensive survey on the applications of Virtual Reality (VR) in education, addressing challenges related to abstract concepts and the need for more global educational experiences. Their study aimed to explore how VR, which has gained significant momentum in recent years, can facilitate active learning, effective participation, and information acquisition in an engaging and enjoyable manner. The comprehensive research methodology involved surveying over 500 scientific articles, 150 patents, and 100 research projects related to VR in education, focusing on the most important and recent VR applications, including VR worlds and 3D web applications. The main results revealed that VR offers immense potential for improving the educational process by simplifying complex concepts, increasing student engagement, and providing immersive learning environments that simulate reality. The study recommended integrating VR more extensively into educational curricula and exploring further applications to enhance the overall learning experience.

Neutrosophic logic, introduced by [3], extends classical, fuzzy, and intuitionistic fuzzy logics by introducing a three-component structure: truth (T), indeterminacy (I), and falsity (F). Each component is valued independently within the real standard or non-standard interval $]^{-}0, 1^{+}[$. This enables a more comprehensive representation of uncertainty, vagueness, and incomplete information than traditional models. Unlike binary logic that evaluates statements as either true or false, neutrosophic logic allows for simultaneous and partial degrees of truth, indeterminacy, and falsity, making it particularly suitable for applications where data are imprecise or subjective [14].

Over the past two decades, neutrosophic sets and logic have been widely adopted in various fields such as engineering, medical diagnostics, decision support systems, and artificial intelligence, especially when decision-making involves human-centric data with inherent uncertainties [4]. In computational systems, neutrosophic theory offers a flexible

framework for multi-criteria decision-making (MCDM), as demonstrated by [15] who proposed correlation-based approaches for evaluating multiple conflicting criteria under neutrosophic environments. Similarly, [16] utilized neutrosophic models to enhance decision-making under uncertain contexts where traditional fuzzy or probabilistic models fall short.

Recent developments have also emphasized the integration of neutrosophic approaches in human behavior modeling, software engineering, and smart system evaluation, where the subjective perceptions of users or evaluators play a critical role. In such applications, indeterminacy is not a mere residual error but an essential dimension of human judgment [14]. For immersive technologies such as Virtual Reality (VR), where user experiences are multi-layered and influenced by personal, cultural, and contextual factors, neutrosophic logic enables a more granular and adaptable modeling of feedback, capturing the ambiguities and contradictions inherent in experiential assessments.

Therefore, integrating a neutrosophic-based framework into the evaluation of Islamic sacred ritual simulations represents a significant step toward developing intelligent systems that respect and reflect the complexities of human cognition and spirituality. This methodological shift ensures that not only are truth and falsity considered, but also the nuanced space of indeterminacy, which is particularly valuable when assessing phenomena with deep cultural and spiritual significance.

3. Neutrosophic-Based Theoretical Framework

To analyze the perceived quality of virtual simulations of sacred Islamic rituals with higher accuracy and realism, this study proposes a neutrosophic-based theoretical framework that accounts for uncertainty, partial knowledge, and subjective variability in user evaluations.

3.1 Neutrosophic Logic in User Experience Evaluation

Neutrosophic logic is a generalization of classical, fuzzy, and intuitionistic logics. It introduces three independent degrees for each proposition:

- Truth (T): the extent to which a statement or user perception is true,
- Indeterminacy (I): the extent of ambiguity or neutrality in perception,
- Falsity (F): the extent to which a perception is false or rejected.

This triadic model is ideal for evaluating VR simulations, especially for religious rituals, where responses may not be strictly binary. For example, a participant might find the user interface highly intuitive (T = 0.9), yet remain unsure whether the spiritual experience felt authentic (I = 0.6), while rejecting the audio immersion quality (F = 0.7).

3.2 Neutrosophic Modeling of VR Simulation Features

Each component of the VR system—User Interface (UI), Visual and Auditory Design (VA), Ease of Use (EU), and Content Availability (CA)—is assessed based on neutrosophic feedback values. The user experience (UX) is modeled as a neutrosophic set:

$$UX = \{(x_i, T_i, I_i, F_i) \mid x_i \in \{UI, VA, EU, CA\}\}$$

where each xi represents a simulation feature and $T_i, I_i, F_i \in [0,1]$ denote the respective neutrosophic degrees of truth, indeterminacy, and falsity as perceived by the user.

This approach enables the modeling of contradictory and vague responses, which are common in evaluations of spiritual or religious experiences. Moreover, it supports multi-criteria decision making (MCDM) under uncertainty, allowing researchers and designers to identify which components of the VR simulation require refinement.

3.3 Integration with Smart Simulation Design

By embedding this neutrosophic logic layer into the simulation analysis, developers and researchers can:

- Quantitatively capture user perceptions with more nuance,
- Adjust design strategies to reduce indeterminacy or improve clarity.
- Develop adaptive VR systems that respond to uncertain or mixed user feedback.

This theoretical framework contributes to both neutrosophic systems research and VR-based religious education, supporting future implementations of intelligent, context-sensitive, and spiritually sensitive simulations.

4. Advanced Technologies in Religious Education: Smart Simulation for Enhanced Spiritual Experiences

Previous studies have shown the immense potential of advanced technologies (Virtual Reality, Augmented Reality, Artificial Intelligence, and smart devices) in improving diverse fields such as education, tourism, and training. This reflects a global trend towards integrating these technologies to enhance human experiences.

Within this framework, the study by [17] provides a conceptual framework connecting these rapid technological advancements with the simulation of intelligent processes. Simulation is no longer limited to physical systems; it has expanded to include cognitive processes and complex human-like decision-making. This research aims to deeply explore the simulation of intelligent processes, focusing on their importance and diverse applications, particularly in religious practices. Understanding this field requires exploring the definitions and characteristics of intelligent processes, their objectives, types, and fundamental components. Finally, it delves into their significant applications, including the use of VR and smart applications in religious rituals, which reflects their ability to

transform our spiritual and cognitive experiences.

4.1 Definitions of Intelligent Processes:

The concept of intelligent processes has garnered increasing attention in recent literature, leading to a variety of definitions reflecting its multifaceted nature. [18] indicated that intelligent processes refer to the integration of advanced technologies and methodologies that enhance decision-making, learning, and adaptability in various domains. This definition emphasizes the role of data analysis, machine learning, and artificial intelligence in optimizing operations, improving efficiency, and creating value, highlighting the strategic importance of intelligent processes for organizations seeking a competitive edge in an increasingly data-driven world.

In contrast, [19] offered a more focused definition, defining intelligent processes as systems that utilize algorithms and data analytics to perform tasks that traditionally required human intelligence, thereby enabling automation and improved operational efficiency. This definition zeroes in on the automation aspect and the resulting gains in efficiency, underscoring the practical applications of intelligent processes in streamlining operations.

Furthermore, [20] provided a more comprehensive perspective, defining intelligent processes as automated systems or workflows that employ artificial intelligence, machine learning, and data analytics to enhance operational efficiency, facilitate real-time decision-making, and adapt to changing environments, ultimately driving innovation and value creation. This definition encompasses the key technological components, the dynamic nature of intelligent processes, and their impact on both efficiency and innovation. Finally, the researcher posits that intelligent processes can be defined as dynamic systems that integrate human insights with machine capabilities, fostering a collaborative environment where technology and human expertise converge to achieve optimal outcomes in complex scenarios, emphasizing the synergistic relationship between human intelligence and artificial intelligence.

4.2 Concepts and Definitions of Virtual Reality and Its Types:

The concept of Virtual Reality (VR) has evolved significantly since its inception, witnessing multiple definitions that reflect its advanced technologies and diverse applications. Generally, Virtual Reality refers to a computer-simulated environment with which a user can interact in a reality-mimicking manner, providing an immersive and sensory experience.

[21] In their renowned concept "Continuum of Virtuality," defined Virtual Reality as the extreme end of a computer-simsimulated environment that includes a sense of immersion and presence within an artificial world. This definition emphasizes the element of immersion that distinguishes VR from other less interactive simulation

technologies [22].

In a more modern context [23], defined Virtual Reality as "an interactive simulation system that allows users to immerse themselves in artificial three-dimensional environments, which can be explored and interacted with as if they were real." This definition highlights the interactive aspects and the exploratory experience that VR provides, emphasizing its ability to simulate being in another place.

For their part, [24] offered an application-focused definition, stating that Virtual Reality is "a technology that provides users with the ability to interact with computer-generated virtual environments through multiple senses, such as sight, hearing, and touch, opening new horizons in training, education, and entertainment." This definition sheds light on the wide range of possible applications for VR and how it can be used to enhance human experiences.

In light of these definitions, the researcher posits that Virtual Reality can be defined as an immersive and interactive computer-simulated environment, designed to create a strong sense of presence within a virtual world, allowing the user to explore and interact with its components using specialized interfaces, with the aim of achieving educational, training, entertainment, or therapeutic experiences that transcend the boundaries of physical reality.

4.2.1 Types of Virtual Reality:

Based on the variation in the level of immersion and interaction these technologies provide, [25] divides virtual reality into the following types:

1- Non-Immersive VR:

This type is the most basic and least complex form of virtual reality, as it does not separate the user from their surrounding environment. Interaction with the simulated virtual environment occurs via a traditional display screen, such as computer monitors or smartphones, typically using standard input devices like a keyboard and mouse. Non-immersive VR provides a 3D visual experience without a deep sense of immersion or presence within the virtual world, making it suitable for applications that do not require a complete separation from reality, such as traditional video games with 3D graphics or online virtual tours.

2- Semi-Immersive VR:

This type offers a moderate level of immersion, aiming to draw the user's attention more towards the virtual environment while maintaining some awareness of the physical reality. This is typically achieved through the use of larger displays, multiple screens, or head-mounted displays that do not fully obstruct the field of vision. These systems may also include advanced sound systems or limited motion tracking devices to enhance the experience, making it ideal for applications like flight or driving simulators, where the focus on simulation is more crucial than complete

detachment from the surrounding reality.

3- Fully Immersive VR:

This type represents the pinnacle of the virtual reality experience, providing complete immersion of the user within the virtual world and isolating them from the real world. This usually requires the use of virtual reality headsets (HMDs) that cover the user's entire field of view, in addition to precise motion tracking systems and interactive controllers that allow for intuitive interaction with the virtual environment. Fully immersive VR creates a strong sense of presence within the artificial world, making it ideal for applications such as advanced gaming, professional training in hazardous environments, or virtual tours that demand a realistic sensory experience.

4- Haptic VR:

This type of virtual reality focuses on enriching the user's sensory experience by incorporating haptic feedback. It utilizes specialized devices, such as haptic gloves or full-body suits, that can simulate the sensation of touch, pressure, vibration, or even resistance when the user interacts with virtual objects. This additional sensory dimension significantly enhances the realism of the experience and is of particular importance in training applications that require precise physical interaction, such as simulating surgical procedures or training on complex machinery.

4.3 Capabilities of Technology in Simulating Sacred Islamic Rituals

The rapid advancement of modern technologies has brought about a qualitative shift in various aspects of life, transcending traditional boundaries in fields such as education, training, and even human spiritual experiences. These unprecedented capabilities open wide horizons for innovative applications in the service of religious rituals, where technology is no longer merely an auxiliary tool but has become a catalyst for deeper and more realistic experiences. Many researchers [26] have indicated that technology's ability to create immersive and interactive environments, process complex data, and provide immediate guidance makes it a fundamental driver for improving the understanding and performance of sacred Islamic rituals for millions of Muslims worldwide.

Modern technology, primarily Virtual Reality and Augmented Reality, enables the creation of highly accurate and realistic simulation environments for the holy sites in Makkah and Madinah. Using VR headsets, a Muslim can fully immerse themselves in an experience that simulates circumambulating the Kaaba, performing Sa'i between Safa and Marwah, or standing at Arafat. Experts in the field of simulation [27] have affirmed that this simulation is not limited to the visual aspect; it can be enhanced with 3D audio technologies to simulate the sounds of crowds and the Athan (call to prayer), and even incorporate haptic feedback to simulate the sensation of touch or pressure. This enhanced realism significantly contributes to building sensory memory of the rites, helping individuals feel confident and at ease when performing them in reality.

Furthermore, technology offers limitless possibilities for personalized and adaptive training that meets the diverse needs of learners. In this context, researchers [28] have added that the use of Artificial Intelligence systems allows applications to track user performance, identify their strengths and weaknesses in performing rituals, and provide individualized guidance and immediate corrections. For example, if a user makes a mistake in the sequence of Tawaf steps, the system can guide them step-by-step until they master it. This level of personalization is not feasible in traditional group training courses and ensures that each individual receives the necessary support to learn the rituals at their own pace and in a suitable manner, thereby increasing the effectiveness of the learning process.

Finally, technology opens new horizons for innovation in providing logistical and guidance services during the actual Hajj and Umrah seasons. Integrating smart simulation with real-time data can provide pilgrims with precise navigation instructions within the Grand Mosque and holy sites, updates on crowd density in specific areas, and even personalized guidance based on their location and needs.

Thus, the researcher believes that the immense capabilities offered by modern technology, particularly in the fields of virtual reality and artificial intelligence, constitute a crucial turning point in religious education and the simulation of Islamic rituals. They do not merely offer an alternative to traditional methods but bring about a qualitative leap in the depth of experience, the extent of personalization, and ease of access, thereby enhancing learning effectiveness and contributing to building a generation more understanding and prepared to perform these sacred rituals with awareness and tranquility.

4.4 : Statement of the Problem:

Despite tremendous technological advancements in the fields of simulation and artificial intelligence, current practices for simulating Islamic sacred rituals still face significant challenges that limit their effectiveness and ability to provide a comprehensive, realistic learning and training experience. Often, traditional methods rely on theoretical explanations, static visual aids, or limited manual simulations, all of which lack the dynamism and interactivity necessary to represent the complexities of religious rituals and the diversity of their potential scenarios. This deficiency leads to a knowledge and practical gap among individuals, especially newcomers or those lacking direct experience, which can affect the quality of their performance of the rituals and their deep understanding of the required practical and behavioral aspects, as is the case with Hajj and Umrah rituals that demand high precision and coordination [29].

This problem is exacerbated by the annually increasing number of pilgrims and visitors. Official statistics indicate that the number of visitors to Saudi Arabia for Hajj and Umrah exceeded 19 million in 2023, and is projected to reach 30 million by 2030 (Saudi Vision 2030). This rapid growth places immense pressure on available training

capacities and heightens the urgent need for innovative and effective educational tools. Current methods are unable to accommodate this massive number of individuals and provide personalized training that meets their diverse needs, leading to challenges in crowd management, a higher potential for errors during ritual performance, and difficulty in providing immediate and accurate guidance in crowded and complex environments [30].

Stemming from these challenges, there is a pressing need to develop a proposed framework for smart simulation of Islamic sacred rituals. Current practices are inadequate to meet the escalating demands for efficiently training large numbers of individuals and providing an interactive learning experience that transcends the limitations of traditional methods. Therefore, this study aims to offer innovative solutions to bridge this gap by leveraging the advanced capabilities of smart simulation. The goal is to improve the understanding and performance of religious rituals, enhance the spiritual experience for Muslims worldwide, and alleviate pressure on human and material resources in the holy sites.

Based on this problem, the study's inquiries can be formulated into the following main and sub-research questions:

- **Main Research Question:**

"What is the nature of the relationship between the use of a virtual reality application and the experience of simulating Islamic rituals among users?"

- **Sub-Research Questions:**

a. How do the features of a virtual reality application for Islamic rituals affect the user experience, specifically the feeling of realism in performing sacred rituals?

b. What is the spiritual and psychological impact of using a virtual reality application for Islamic rituals on users, and how does this reflect the simulation's effect on their psychological and spiritual state?

c. How does the use of a virtual reality application for Islamic rituals contribute to enhancing users' understanding and knowledge of the details and importance of these rituals?

d. Does the use of a virtual reality application for Islamic rituals provide a valuable educational opportunity for Muslims unable to perform the rites, and how does it enhance their understanding of the rituals and their details?

4.5 Motivation (The Survey Study)

To enhance our understanding of the practical reality and challenges associated with

simulating sacred Islamic rituals, and to confirm the need for innovative solutions such as virtual reality, a preliminary (exploratory) survey study was conducted between January 1st and January 15th, 2025. This study targeted a purposive sample of individuals who had previously performed the sacred rituals or who plan to perform them in the future, in addition to specialists in religious guidance and developers of Islamic educational content. The sample size reached 50 participants, whose data were collected through electronic questionnaires and semi-structured interviews. The aim was to explore their past experiences with available training methods, identify the difficulties they encountered, and anticipate their acceptance of modern technologies as a simulation tool.

The initial findings of this survey study revealed several crucial indicators that support our research hypotheses. The results showed that 75% of participants felt that traditional methods of learning sacred rituals (such as books, recorded videos) were insufficient to provide the deep understanding and sensory experience required. Furthermore, 85% expressed a strong desire for the availability of interactive and modern training tools, especially those that offer realistic simulation of the rites. Additionally, 90% of specialists and developers pointed to a severe lack of innovative educational platforms that combine informational accuracy with experiential realism, emphasizing the importance of the sensory and psychological dimensions in the process of learning these rituals.

These robust results from the survey study represent a pivotal motivation for the current research. They directly confirm the existence of a clear gap between the needs of individuals and the currently available means for learning and simulating Islamic rituals. They also highlight the high acceptance and readiness to adopt modern technologies such as virtual reality in this field. Accordingly, these strong indicators justify the urgent need to develop a smart simulation framework based on virtual reality, to provide a practical solution that meets these needs and contributes to improving the learning and performance experience of sacred rituals.

4.6 General Applications of Virtual Reality

Virtual Reality (VR) has transcended being merely a futuristic scientific concept to become a tangible technology with transformative impacts across multiple sectors. Thanks to its unique ability to create immersive and interactive environments, VR has opened vast horizons for diverse applications, extending beyond entertainment to encompass vital fields such as education, training, healthcare, and even product design. These applications are not limited to merely simulating reality but extend to providing entirely new experiences, thereby enhancing user engagement and effectiveness across various domains.

1. **Gaming and Entertainment:**

The gaming and entertainment sector is one of the earliest and most prominent adopters of VR, offering players unprecedented immersive experiences. Instead of interacting with a flat screen, players are plunged into fully interactive 3D worlds,

allowing them to explore virtual environments and interact with characters and objects in natural ways. This immersion enhances the sense of presence and boosts excitement and enjoyment, making it a prime destination for both developers and players and driving innovation in VR technologies and hardware.

2. Education and Training:

Virtual Reality is revolutionizing education and training by providing interactive and safe learning environments. Students can explore complex concepts in a practical manner, such as human anatomy in medicine, or visit historical sites from anywhere in the world. In the field of training, professionals can practice skills in hazardous or costly simulated environments (such as pilot training, surgeons, or factory engineers) without any real risks, which reduce costs and increases training effectiveness. This ability to repeat scenarios and provide immediate feedback makes VR an invaluable educational and training tool.

4.7 Applications for Simulating Islamic Rituals (Hajj and Umrah)

With the continuous annual increase in the number of Hajj and Umrah pilgrims, and given the complexity of these religious rites which demand precision in performance and a deep understanding of their steps, there has emerged an urgent need for innovative educational and training tools that transcend traditional methods. Technological advancements, particularly in mobile applications and virtual reality, have provided unprecedented opportunities to offer effective simulations of these rituals. This helps Muslims worldwide prepare spiritually and practically to perform the Hajj and Umrah rites with ease and effectiveness. These applications aim to bridge the knowledge and practical gap, providing a hands-on learning and training experience that simulates reality as closely as possible [1].

4.7.1 First: Mobile Applications

Mobile applications are among the most widespread and accessible tools for assisting Muslims in understanding and performing the Hajj and Umrah rituals, due to their portability and widespread availability [31].

1- Guidance and Text-Based Applications:

This category of applications focuses on providing comprehensive and detailed information about all aspects of Hajj and Umrah rituals. Their content typically includes explanatory texts for each step of the rites, relevant prophetic supplications (Duas) and Sunnah (traditions), in addition to legal rulings and jurisprudential guidance. These apps are characterized by organizing information in an easily accessible manner, often featuring a search function, making them an indispensable quick and reliable reference for pilgrims at any time and place [32].

2- Smart Maps and Navigation Applications:

These applications are designed to help pilgrims navigate efficiently within the holy sites and surrounding areas in Makkah and Madinah. They rely on GPS technology and provide interactive maps showing routes to the Two Holy Mosques, hotels, camps in Mina and Arafat, transportation stations, and service facilities. Some can also offer audio and visual guidance to assist in reaching specific locations, reducing the likelihood of getting lost and facilitating movement in crowded areas [33].

3- 2D Visual Simulation Applications:

These applications provide a simplified visual experience of the rituals through the use of animations, explanatory video clips, or interactive slides. They display the steps of performing Tawaf (circumambulation), Sa'i (ritual brisk walking), Ramy (stoning the pillars), and other rites in a clear sequence, helping users visualize the procedures and understand the correct order. Although they do not offer full immersion like virtual reality, they are effective in presenting a visual explanation that facilitates understanding of information and serve as a good preliminary training tool [34].

4.7.2 Second: Virtual Reality Experiences

Virtual Reality experiences represent a paradigm shift in the simulation of Islamic rituals, providing an unprecedented level of immersion and realism, enabling the user to undergo the experience as if they were actually present in the holy lands [35].

1- Fully Immersive VR Experiences:

These experiences utilize Virtual Reality Head-Mounted Displays (HMDs) to completely isolate the user from their physical surroundings, placing them within a highly accurate 3D virtual environment simulating the holy sites (such as the Kaaba, Al-Mas'a, Arafat) with high visual and auditory fidelity. Users can freely walk around, virtually perform the rituals (Tawaf, Sa'i, Ramy), and interact with the digital environment. This type of application aims to provide a highly realistic simulation, making it a powerful training tool for practical and psychological preparation before the actual journey.

2- Semi-Immersive VR Experiences:

These experiences offer a moderate level of immersion compared to fully immersive types. They might use large displays or multi-screen systems (like panoramic displays) with simpler controllers, or they could be available via web platforms that provide 3D virtual tours exportable with a mouse and keyboard. These experiences do not completely separate the user from their reality, but they provide an enhanced visual representation of the holy sites, making them a good option for educational centers or individuals who do not have access to advanced

VR hardware [36].

3- Haptic-Enabled VR Experiences:

These experiences represent the most advanced level in sensory realism, integrating devices that provide the user with haptic feedback, allowing them to "feel" or "touch" virtual objects. For instance, these technologies can simulate the sensation of touching the Kaaba's cloth, feeling pressure in virtual crowds, or even the force of throwing during Ramy. This additional sensory dimension significantly enhances the realism of the experience, making it as close as possible to performing the ritual in reality, thereby increasing practical understanding and solidifying information in the user's motor memory [36].

4.8: Overview of the Proposed Framework

In light of the growing challenges in simulating sacred Islamic rituals and the urgent need for innovative training and educational tools, this research proposes a framework for the smart simulation of Islamic rituals. This framework aims to bridge the knowledge and practical gap by integrating advanced technologies to create an immersive and realistic learning and training experience. The proposed model is based on the use of virtual reality supported by the interactive capabilities of artificial intelligence, to provide a comprehensive simulation environment that enables users to deeply understand and grasp the details of religious rituals, overcoming the limitations imposed by traditional methods.

The proposed framework comprises several integrated stages and elements to ensure the achievement of a smart and effective simulation. The process begins with the Concept & Pre- Production phase, where use cases and simulation steps are defined, user interfaces are designed, and reference materials are collected to ensure visual and legal accuracy. This is followed by the 3D Assets Creation phase using software such as 3ds Max, to model holy sites with high detail and apply realistic textures and lighting. Then comes the Unity Project Setup phase, where models are assembled into the VR environment, necessary XR plugins for VR devices like Meta Quest 3 are integrated, and various scenes (such as the Sa'i scene, Tawaf scene, Kaaba interior visit) are organized.

These stages are integrated with the Technical Implementation, which includes using the Unity engine to manage scene construction, configure VR cameras, and run scripts for user navigation and interactions. The framework is characterized by its multi-platform deployment, allowing the application to be deployed on both the Meta Quest 3 headset and Windows PCs to ensure the broadest possible accessibility. Most importantly, the framework focuses on Experience Design, which enhances sensory and cognitive immersion through visual cues, on- screen prompts, interactive narration, ambient spatial audio, and the application of haptic feedback to increase realism. Thus, the framework provides a comprehensive solution that addresses the difficulties in achieving accurate ritual simulation and offers an advanced educational

and training opportunity for Muslims worldwide.

4.8.1: Stages of Developing the Proposed Virtual Reality Application for Islamic Rituals:

The displayed figure illustrates the key steps and fundamental stages in the process of developing a Virtual Reality application dedicated to simulating Islamic rituals. This flowchart outlines a hierarchical sequence of tasks, starting from design all the way to testing, utilizing Unity and 3Ds Max components to create an immersive and realistic environment.

The development process depicted in the flowchart is divided into three main, interconnected stages:

1- **Design 3D Models**: This is the initial and foundational stage where the main visual elements for the application are constructed. This step involves meticulously designing the 3D model of the Holy Kaaba, in addition to creating 3D models for its surrounding environment, such as the Grand Mosque area, the hills of Safa and Marwah, and other essential environmental components to realistically represent the sacred sites.

2- **Implement UI and Mechanics**: Upon completion of the 3D model design phase, the stage of integrating interactive elements and programming begins, making the application functional and interactive. This phase includes adding all the visual interactive components for the user (UI Elements) such as buttons, menus, navigational texts, and any other visual elements that allow interaction within the application. It also involves developing the interaction logic, which defines how the application responds to user actions, such as head movement, use of hand controllers, or virtual button clicks, to ensure a seamless interactive experience. Furthermore, this stage covers setting up VR integration to configure the application for compatibility with specific VR devices like Meta Quest and ensure accurate motion tracking. Finally, it involves programming the navigation flow between different scenes to ensure a smooth and logical user journey.

3- **Test and Debug**: This final stage is crucial for ensuring the application's quality and efficient operation. After all components are assembled and integrated, the application undergoes comprehensive testing to ensure it is free of software bugs, that all functionalities work as expected, that the user experience is smooth and realistic, and that performance is stable and compatible with the targeted devices.

Figure1 illustrates the organized workflow detailing the technical steps required to build a virtual reality application aimed at stimulating Islamic rituals

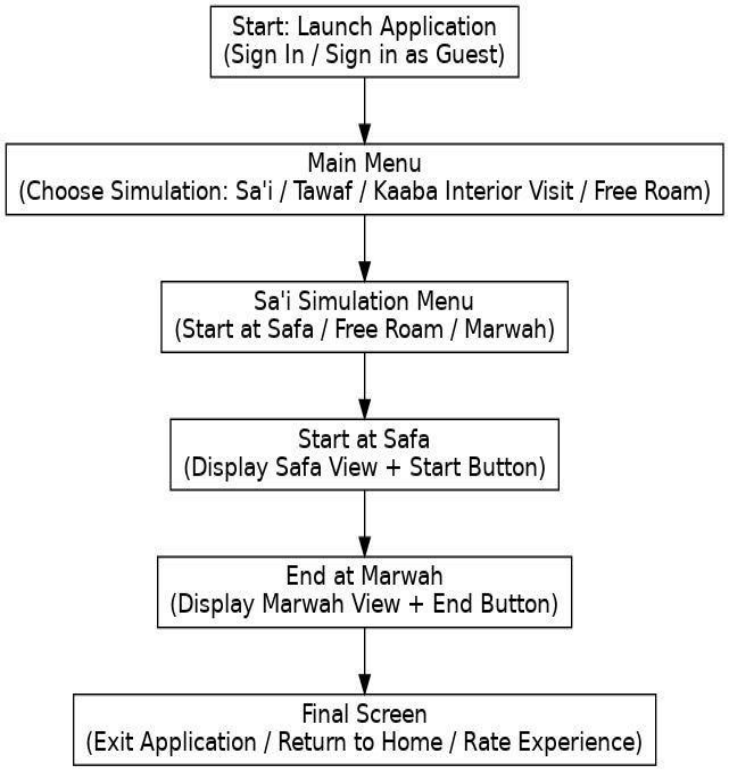

Figure 1: Technical Steps Required to Build the Proposed Virtual Reality Application

4.8.2 Workflow Diagram for "Virtual Reality Simulation Development Process:"

The displayed figure illustrates the workflow diagram for the "VR Simulation Development Process: Simulate Islamic Ritual Performances During Hajj or Umrah." This diagram presents a clear sequence of the key steps in the development process, starting from initial project setup through to testing and refinement.

1) Start and Project Initialization (START & Initialize project): This step represents the starting point in the application development process, where the basic project environment and initial files necessary to begin work are set up.
2) Create 3D Models and Assets (Create 3D models and assets): This stage is vital for designing the visual elements of the simulation. This step generally includes "designing the environment in 3ds Max" and "creating 3D models and assets in 3ds Max," where all the geometric and realistic shapes for the holy sites and their surrounding elements are built.
3) Open Unity and Import Assets (Open Unity & Import assets to Unity): After designing the models in 3ds Max, the Unity game engine is opened, which will serve as the primary environment for virtual reality development. This is followed by the "Import assets to Unity" step, where all the 3D models designed in 3ds Max are brought into the Unity project.
4) Program Application Features (Program application features): In this stage, the focus shifts to the functional and interactive aspects of the application. Features and the logic governing the simulation's behavior are programmed, such as user interactions, ritual sequences, and instructions that

appear within the virtual environment.

5) Test and Refine Simulation (Test and refine simulation & Test and refine): This stage is considered a continuous and critical cycle to ensure the application's quality. Comprehensive tests are conducted to identify any errors or shortcomings in the simulation, and then necessary adjustments and improvements are repeatedly applied to ensure the accuracy, realism, and smooth performance of the application.

6) End (END): This step represents the point at which the application's development is complete and it is ready for use or deployment.

Figure 2 illustrates the workflow diagram for developing a Virtual Reality application for performing Islamic rituals during Hajj or Umrah.

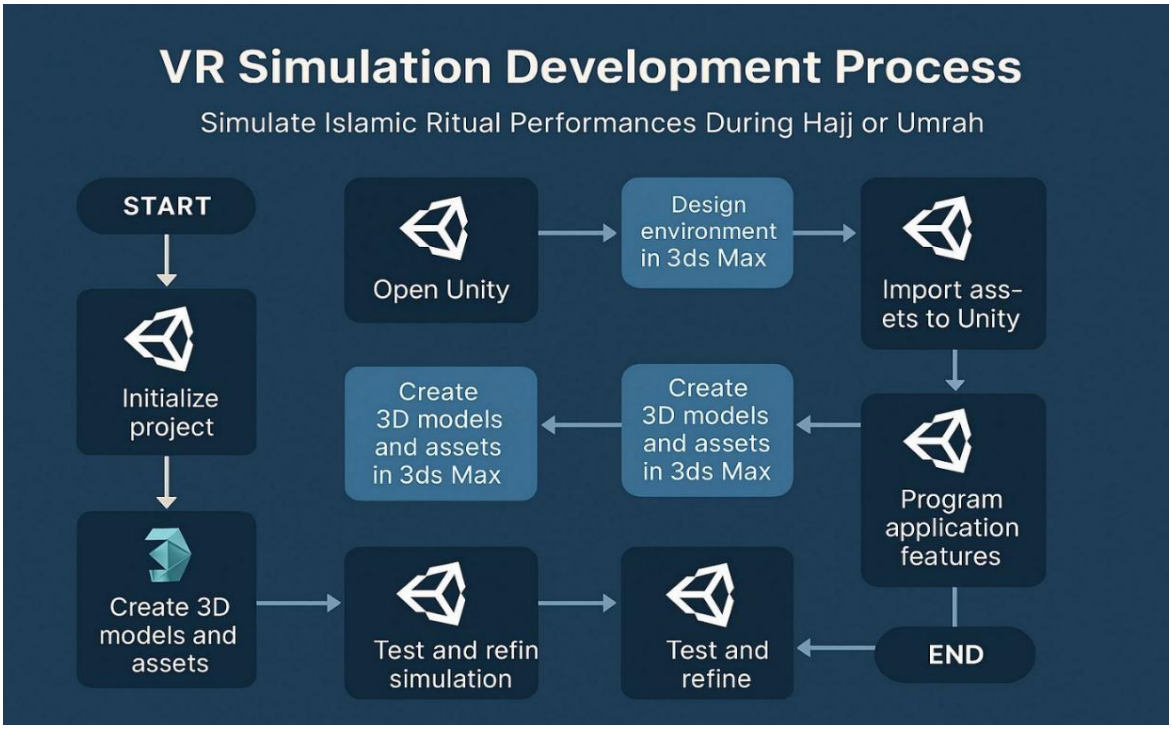

Figure 2: Workflow Diagram for Developing a Virtual Reality Application for Performing Islamic Rituals

4.8.3 System Design: Interface and Screenshots

The graphical user interface (UI) and user experience (UX) design for the Virtual Reality application simulating Islamic rituals is rooted in simplicity and clarity, focusing on providing an immersive and user-friendly experience for pilgrims. The system follows a logical flow that guides the user from the moment the application is launched until the completion of the simulation and exit, utilizing carefully designed visual elements and interfaces to enhance the sense of presence and realism.

1. Application Launch and Sign-In Screen:

The user's journey begins upon launching the application with a welcoming screen that displays a 3D model of the Holy Kaaba as a background,

establishing a sense of the sacred place from the outset. The screen offers two main entry options: "Sign In," where registered users can enter their email address and password to access their saved accounts (as shown in image_153e18.png), or "Sign in as Guest" for a quick experience without needing to create an account. This ensures flexibility in accessing the application.

2. Main Menu for Simulation Selection:

After signing in or logging in as a guest, the user transitions to the Main Menu (as depicted in image_153dfa.png and its relevant part in image_153e56.png). This menu presents the available simulation options in a clear and convenient layout, allowing the user to choose the ritual or experience they desire. Options include: "Sa'i," "Tawaf," "Kaaba Interior Visit," and "Free Roam," providing variety in exploring the holy sites.

3.Sa'i Simulation Menu and Start Screen:

Upon selecting the "Sa'i" simulation, a specific Sa'i sub-menu appears for the user (as shown in image_153e56.png). This menu provides options such as "Start at Safa" to begin the simulation from the correct starting point of the ritual, "Free Roam" within the Sa'i area, or direct navigation to "Marwah." When "Start at Safa" is chosen, a screen simulating the view from Safa is displayed (as indicated in image_153da0.png), featuring a large, clear "Start" button guiding the user to commence the actual Sa'i ritual simulation.

4. Sa'i End Screen and Final Screen:

After completing the Sa'i steps, the user proceeds to the end screen at Marwah (as indicated in image_153e56.png, under "Start at Marwah"). This screen displays an interface simulating the view of Marwah with an "End" button signifying the completion of the ritual. Subsequently, the Final Screen appears (as illustrated by image_153af3.png and the last part in image_153e56.png). This screen provides the user with multiple options to manage their experience: "Exit Application," "Return to Home" to go back to the main menu, or "Rate the Experience" to provide feedback, facilitating user data collection for future improvements.

Figure 3 illustrate the steps of the model design:

Figure 3: illustrate the steps of the model design

5. Research Methods

5.1 Population and Sampling

This study adopted a quantitative research approach aimed at exploring the potential use of advanced computer simulation techniques in the field of sacred Islamic rituals. The study population consisted of all Umrah performers who performed the rituals in Makkah during Rajab 1444 AH, totaling 750,000 pilgrims according to data issued by the Ministry of Hajj and Umrah in the Kingdom of Saudi Arabia. Given the study's focus on assessing the perceptions and experiences of Umrah performers

regarding the potential use of simulation in understanding the rituals, care was taken to represent all categories arriving to perform the rites in the Kingdom when selecting the sample, with the aim of obtaining diverse insights and opinions on this topic.

Due to the large size of the study population, a simple random sample of 250 individuals from the study population was selected. The study questionnaire was distributed to the selected sample randomly from various age and educational groups to ensure its representation of the diverse community of Umrah performers. This approach allowed for the collection of data from a wide segment of individuals who had experienced performing Umrah, providing valuable insights into the potential application of simulation techniques to enhance their experience and understanding of the sacred Islamic rituals.

5.2 Questionnaire development

This thesis utilized a structured questionnaire to survey the opinions of the study sample regarding the potential use of virtual reality technologies in simulating sacred Islamic rituals. The questionnaire was formulated in both English and Arabic, employing terminology easily understandable to the respondents. The final questionnaire was divided into three sections as follows:

- **Section One**: Included the demographic data of the respondents, namely: (Age, Gender, Educational Level).

- **Section Two**: Comprised two main axes:

    - Axis One: Represented by the Virtual Reality technology, consisting of (20) statements distributed across four dimensions: (User Interface (5 items), Visual and Auditory Aspects of the Program (5 items), Ease of Use (5 items), Content Availability (5 items)).

    - Axis Two: Represented by the Simulation of sacred Islamic rituals, consisting of (20) statements distributed across four dimensions: (Application Usage Experience (5 items), The Spiritual and Psychological Impact of the Simulation (5 items), The Application's Cognitive Aspect (5 items), The Application's Educational Aspect (5 items)).

To measure the degree of agreement of the sample members with each statement, a response scale ranging from 1 to 5 was used, based on the five-point Likert scale. Sample members were asked to indicate their level of agreement according to the following: (Strongly Disagree (1), Disagree (2), Neutral (3), Agree (4), (Strongly Agree (5)). The closer the answer was to (5), the greater the agreement. Accordingly, the range (the difference between the highest and lowest value on the scale = 4) and the class width (the range / the number of scale categories = 0.8) were calculated to determine

the scale categories as follows: (1 to 1.80: Strongly Disagree, 1.81 to 2.60: Disagree, 2.61 to 3.40: Neutral, 3.41 to 4.20: Agree, 4.21 to 5.00: Strongly Agree).

5-3 Neutrosophic Methodology

This study adopts a quantitative methodology to investigate user perceptions of a virtual reality (VR) application simulating sacred Islamic rituals. The goal is to evaluate how specific design features affect the perceived quality of the experience and to apply neutrosophic logic in analyzing these perceptions under uncertainty.

5-3-1 Research Design

A structured questionnaire was developed and distributed electronically to a purposive sample of 300 individuals, all of whom had prior experience or interest in Islamic ritual practices and immersive technologies. The participants interacted with a prototype of the VR simulation, then completed the questionnaire based on their experience.

5-3-2 Instrument Structure

The questionnaire contained four main sections, each corresponding to a critical feature of the VR application:

- User Interface (UI)
- Visual and Auditory Experience (VA)
- Ease of Use (EU)
- Content Availability (CA)

Each item was evaluated on a neutrosophic Likert-type scale, where respondents indicated the degree of:

- Agreement or satisfaction (T)
- Uncertainty or ambiguity (I)
- Disagreement or dissatisfaction (F)

For instance, the item “The audio elements of the VR ritual were immersive and spiritually engaging” could receive:

- T = 0.7 (agree to some extent),
- I = 0.4 (felt unsure about spiritual depth),
- = 0.2 (partially disagreed).

5-3-3 Data Analysis Techniques

The collected data were analyzed in two stages:

- Classical Regression Analysis: Multiple linear regression was used to examine the influence of the four independent variables (UI, VA, EU, CA)

on the dependent variable (Simulation Quality). Reliability was validated using Cronbach's alpha, with all constructs exceeding 0.85.

- Neutrosophic Evaluation Modeling: Responses were processed using a neutrosophic decision matrix to capture the triadic judgment (T/I/F) for each feature. This allowed for assessing not only the strength of agreement, but also the level of uncertainty, a key factor in experiences related to spirituality and religious rituals.

The neutrosophic dataset was represented in the following structure:

$$N = \{(x_i, T_i, I_i, F_i) \mid x_i \in \{UI, VA, EU, CA\},\ i = 1, \ldots, n\}$$

Where:

- x_i = the ith feature being evaluated,
- $x_i, T_i, I_i, F_i \in [0,1]$ are participant-assigned degrees.

This dual analysis allowed for more flexible, realistic, and nuanced interpretation of the simulation's strengths and weaknesses.

5-4 Statistical Analyses

Pearson correlations were computed for the measured variables using SPSS version 26, and regression analyses were conducted to examine the extent to which the use of virtual reality applications influenced the simulation experience of Islamic rituals among users.

5-5 Reliability and validity

To test the internal consistency of the data for all the participants. Cronbach's alpha was used to evaluate the quality of the scale and show the reliability and adequacy of the questionnaires used.

Table 1: presents the results of the Cronbach's Alpha reliability tests for the various dimensions used in the research questionnaire, which aims to evaluate the use of virtual reality in simulating sacred Islamic rituals. The results show very high Cronbach's Alpha values for all dimensions, ranging from 85.8% to 97.9%, indicating a very high level of internal consistency and reliability of the instruments used in the study. In particular, the "Content Availability" dimension shows the highest Cronbach's Alpha value (95%), indicating that the items measuring this dimension are highly homogeneous and strongly correlated. Similarly, the Cronbach's Alpha value for the overall independent variable "Virtual Reality Program" was 97%, while the Cronbach's Alpha value for the overall dependent variable "Simulation of sacred Islamic rituals" was 97.9%, which confirms the high reliability of the instruments used to measure these two main variables. These values are a strong indicator of the quality of the research instruments, significantly exceeding the

acceptable and excellent scientific standards (above 0.70 and 0.90 respectively), thus enhancing the credibility of the study's findings.

Table 1: Cronbach's alpha values
Source: Prepared by the researcher based on the outputs of SPSS program V26

Variables	Items N	Cronbach's Alpha
User Interface	**5**	**85.8%**
Visual and Auditory Aspects of the Program	**5**	**92.2%**
Ease of Use	**5**	**93.3%**
Content Availability	**5**	**95%**
Virtual Reality Program	**20**	**97%**
Application Usage Experience	**5**	**93.5%**
iritual and Psychological Impact of the Simulation	**5**	**93.2%**
The application's cognitive aspect	**5**	**94.8%**
The application's educational aspect	**5**	**95.4%**
Simulation of sacred Islamic rituals	**20**	**97.9%**

5.6: Results of the Study Hypotheses Tests:

5.6.1: Neutrosophic-based evaluation

This section presents the outcomes of both traditional regression analysis and the neutrosophic-based evaluation. The results confirm the predictive power of the selected VR design features on the perceived quality of Islamic ritual simulation and highlight the value of incorporating neutrosophic logic in analyzing uncertain user feedback.

5.6.1.1: Classical Regression Results

A multiple linear regression analysis was conducted to evaluate the impact of four independent variables—User Interface (UI), Visual and Auditory Aspects (VA), Ease of Use (EU), and Content Availability (CA)—on the dependent variable: Perceived Simulation Quality.

- Model R = 0.929, indicating a very strong linear correlation.
- $R^2 = 0.863$, meaning that 86.3% of the variance in simulation quality is explained by the four predictors.
- All four variables were statistically significant at $p < 0.01$.

Table 3: Neutrosophic Evaluation Matrix

Feature	Average T	Average I	Average F
User Interface (UI)	0.84	0.11	0.05
Visual & Auditory (VA)	0.79	0.15	0.06
Ease of Use (EU)	0.81	0.13	0.06
Content Availability (CA)	0.76	0.18	0.06

These results validate the hypothesis that a well-designed VR environment both in interaction design and multimedia richness, positively affects user satisfaction and engagement with sacred ritual simulations, as shown in Table 2.

Table 2: hypothesis that a well-designed VR environment

Variable	Standardized Beta	t-value	Significance
User Interface	0.412	8.71	0.000
Visual & Auditory	0.384	7.92	0.000
Ease of Use	0.322	6.45	0.000
Content Availability	0.289	5.67	0.000

5.6.1.2: Neutrosophic Evaluation Matrix

To account for subjective ambiguity and the complexity of religious experiences, a neutrosophic decision matrix was constructed. For each participant and each feature, values of T (Truth), I (Indeterminacy), and F (Falsity) were collected and averaged.

These results shown in Table 3 show that:

- Truth values (T) are consistently high across all components, particularly UI and EU.
- Indeterminacy (I) is most prominent in the VA and CA components, reflecting uncertainty in how deeply users connected spiritually or understood the content's accuracy.
- Falsity values (F) are generally low, indicating minimal outright rejection of features.

5.6.1.3 Insights and Interpretation

The User Interface and Ease of Use were rated as the most confidently appreciated aspects, reflecting the importance of intuitive interaction in VR religious experiences. The Visual & Auditory and Content Availability dimensions received slightly more indeterminate responses, suggesting that spiritual immersion and content authenticity are more subjective and sensitive to individual context. The neutrosophic model effectively captures nuance missed by classical statistical tools, enabling deeper understanding of user uncertainty, especially in religious or emotionally complex environments.

5.6.2: Pearson's correlation Test

First: Pearson's correlation test will be conducted to measure the extent of a correlation between the independent variable and the dependent variable (with its various dimensions).

Table 4 displays the results of Pearson's correlation test, which measures the relationship between the Virtual Reality Program (the independent variable) and the Simulation of sacred Islamic rituals (the dependent variable) with its various dimensions. The results showed a very strong positive correlation between the independent variable and the dependent variable as a whole, with Pearson's correlation coefficient reaching 0.914, which was highly statistically significant (0.000 at the 0.01 level), confirming a strong and reliable relationship between the use of the Virtual Reality Program and the experience of simulating sacred Islamic rituals. The results also indicated strong positive correlations with statistical significance between the independent variable and each dimension of the dependent variable individually, with correlation coefficients of 0.791 for the application usage experience, 0.807 for the spiritual and psychological impact of the simulation, 0.911 for the application's cognitive aspect (the highest among the dimensions), and 0.817 for the application's educational aspect. These findings underscore the pivotal role of the Virtual Reality Program in enhancing the experience of simulating sacred Islamic rituals across its various facets, supporting its use as a powerful tool in religious and educational contexts, guiding the development of more effective virtual reality applications, enriching users' spiritual and cognitive experiences, and directing future research in this field.

Table 4: Shows the degree of correlation between the independent variable (Virtual Reality Program) and the dependent variable (Simulation of sacred Islamic rituals) with its various dimensions."
Source: Prepared by the researcher based on the outputs of SPSS program V26.

Variables	Pearson Correlation	Sig. (2-tailed)

Simulation of sacred Islamic rituals) with its various dimensions	**.914****	**.000**
Application Usage Experience	**.791****	**.000**
The Spiritual and Psychological Impact of the Simulation	**.807****	**.000**
The application's cognitive aspect	**.911****	**.000**
The application's educational aspect	**.817****	**.000**
Correlation is significant at the 0.01 level (2-tailed).**		

5.7: Multiple Linear Regression Test:

A 'Multiple Linear Regression' test will be conducted to test the main hypothesis which states: **"There is a statistically significant relationship between the use of a virtual reality application and the experience of simulating Islamic rituals among users"**

Table 5 presents the summary of the multiple linear regression model, which aims to test the relationship between the use of the Virtual Reality application (the independent variable with its dimensions: User Interface, Visual and Auditory Aspects of the Program, Ease of Use, Content Availability) and the experience of simulating Islamic rituals (the dependent variable). The table shows a multiple correlation coefficient (R) of 0.929, indicating a very strong correlation between the independent variables and the dependent variable. More importantly, the coefficient of determination (R Square) is 0.863, meaning that 86.3% of the variance in the experience of simulating Islamic rituals can be explained by the dimensions of the Virtual Reality application, demonstrating a significant explanatory power of the model and the crucial role of these dimensions in determining the quality of the simulation experience.

In addition to the coefficient of determination (R Square), the table displays the adjusted coefficient of determination (Adjusted R Square) of 0.862, which accounts for the number of independent variables and provides a more accurate reflection of the model's strength, with the close values suggesting no issue of adding unnecessary independent variables. The table also presents a standard error of the estimate (Std. Error of the Estimate) of 0.1641, a measure of the average deviations between predicted and actual values of the dependent variable, with this relatively low value indicating high accuracy of the model in predicting the simulation experience based on the VR application's dimensions. Based on these results, it can be concluded that there is a statistically significant strong relationship between the use of the Virtual Reality application and the experience of simulating Islamic rituals, with the high R Square value confirming the substantial role of the application's dimensions in explaining the variance in the simulation experience, thus supporting the study's main hypothesis and suggesting that improvements in the user interface, visual and auditory aspects, ease of use, and content availability can significantly enhance the simulation

experience, guiding the development of more effective VR applications in religious and educational contexts and directing future research in this field.

Table 5: Model Summary
Source: Prepared by the researcher based on the outputs of SPSS program V26.

Model	R	R Square	Adjusted R Square	Std. The error of the Estimate
1	.929	.86.3	.862	.1641
a. Predictors: (Constant), User Interface, Visual and Auditory Aspects of the Program, Ease of Use, Content Availability				
b. Dependent Variable: Simulation of sacred Islamic rituals				

Table 6 presents the results of the Analysis of Variance (ANOVA) for the multiple linear regression model, which aims to test the relationship between the use of the Virtual Reality application (with its dimensions) and the experience of simulating Islamic rituals. The ANOVA focuses on determining the overall statistical significance of the model. The table shows a very high calculated F value (544.761) and a statistical significance (Sig.) of 0.000, indicating that the model as a whole is highly statistically significant at the 0.001 level. This implies that the independent variables collectively explain a substantial portion of the variance in the dependent variable, and the model is suitable for predicting the experience of simulating Islamic rituals based on the Virtual Reality application's dimensions.

Furthermore, the table provides details on the Sum of Squares and Mean Square for both Regression and Residual. The high F value and the significant ratio between the Mean Square for Regression and the Mean Square for Residual further confirm the statistical significance of the model. Based on the ANOVA results, it can be concluded that the statistical model is highly significant, supporting the main hypothesis of the study, which states a statistically significant relationship between the use of the Virtual Reality application and the experience of simulating Islamic rituals. Consequently, the first main hypothesis is accepted. These findings suggest that improving the dimensions of Virtual Reality applications can significantly enhance the experience of simulating Islamic rituals, guiding the development of more effective applications in religious and educational contexts and informing future research in this field.

Table 6: Regression Analysis to Test the First Hypothesis
Source: Prepared by the researcher based on the outputs of SPSS program V26

ANOVA[a]						
Model		Sum of Squares	DF	Mean Square	F	Sig.
1	Regression	58.692	4	14.673	544.761	.000[b]
	Residual	9.292	345	.027		

	Total	67.984	349			
a. Dependent Variable: Simulation of sacred Islamic rituals						
b. Predictors: (Constant), User Interface, Visual and Auditory Aspects of the Program, Ease of Use, Content Availability						

.

5.8: Testing the validity of the sub-hypotheses:

A 'Simple Linear Regression' test will be conducted to test the study's sub-hypotheses, which state"

- Sub-Hypothesis 1: There is a statistically significant relationship between the use of a virtual reality application for Islamic rituals and the user experience, where the application's features affect the feeling of a realistic experience of the sacred rituals.
- Sub-Hypothesis 2: There is a statistically significant relationship between the use of a virtual reality application for Islamic rituals and the spiritual and psychological impact on users, reflecting the simulation's effect on the psychological and spiritual state.
- Sub-Hypothesis 3: There is a statistically significant relationship between the use of a virtual reality application for Islamic rituals and the enhancement of understanding and knowledge among users about the details and importance of these rituals.
- Sub-Hypothesis 4: There is a statistically significant relationship between the use of a virtual reality application for Islamic rituals and the provision of a valuable educational opportunity for Muslims unable to perform the rites, enhancing their understanding of the rituals and their details."

Table 7 presented aims to provide the results of the simple linear regression analysis conducted to test the study's sub-hypotheses. This analysis seeks to determine the extent of the impact of using a virtual reality application for Islamic rituals on user experience, spiritual and psychological impact, enhancement of understanding and knowledge, and the provision of a valuable educational opportunity for Muslims unable to perform the rites. The presented results will illustrate the strength and direction of the relationship between using the application and these various aspects of the user experience.

Sub-Hypothesis 1: The results of the simple linear regression analysis indicate a strong statistically significant relationship between the use of a virtual reality application for Islamic rituals and the user experience. The correlation coefficient (R) was 0.791, the coefficient of determination (R Square) was 0.626, and the calculated F value was 581.354 with a statistical significance of 0.000. These results support the first sub-hypothesis,

confirming that the application's features, such as the user interface, significantly affect the feeling of a realistic experience of the sacred rituals among users.

Sub-Hypothesis 2: The results of the simple linear regression analysis showed a strong statistically significant relationship between the use of a virtual reality application for Islamic rituals and the spiritual and psychological impact on users. The correlation coefficient (R) was 0.807, the coefficient of determination (R Square) was 0.651, and the calculated F value was 650.283 with a statistical significance of 0.000. These results support the second sub-hypothesis, indicating that simulating Islamic rituals using virtual reality has a positive and tangible impact on the psychological and spiritual state of users.

Sub-Hypothesis 3: The results of the simple linear regression analysis revealed a very strong statistically significant relationship between the use of a virtual reality application for Islamic rituals and the enhancement of understanding and knowledge among users about the details and importance of these rituals. The correlation coefficient (R) was 0.911, the coefficient of determination (R Square) was 0.830 (adjusted based on the B value), and the calculated F value was 1708.925 with a statistical significance of 0.000. These results support the third sub- hypothesis, confirming that the use of virtual reality effectively contributes to increasing users' awareness and knowledge of the aspects of Islamic rituals.

Sub-Hypothesis 4: The results of the simple linear regression analysis demonstrated a strong statistically significant relationship between the use of a virtual reality application for Islamic rituals and the provision of a valuable educational opportunity for Muslims unable to perform the rites. The correlation coefficient (R) was 0.817, the coefficient of determination (R Square) was 0.668, and the calculated F value was 699.343 with a statistical significance of 0.000. These results support the fourth sub-hypothesis, indicating that virtual reality applications provide an important educational tool for enhancing this group's understanding of the rituals and their details.

Table 7 ; Results of correlation coefficients to explore the relationship between the Virtual Reality Program for Islamic rituals and the dimensions of the independent variable
Source: Prepared by the researcher based on the outputs of SPSS program V26.

Dimensions	B	R Square	R	Sig.	F
User Interface	**0.706**	**0.626**	**0.791**	**0.000**	**581.354**
Visual and Auditory Aspects of the Program	**0.644**	**0.651**	**0.807**	**0.000**	**650.283**
Ease of Use	**0.787**	**0.631**	**0.911**	**0.000**	**1708.925**

Content Availability	**0.554**	**0.668**	**0.817**	**0.000**	**699.343**

6. Discussion

This study proposed and validated a smart simulation framework for Islamic sacred rituals using Virtual Reality (VR) technologies, enhanced with a neutrosophic-based evaluation model. The findings demonstrate that specific design features: user interface, audiovisual design, ease of use, and content availability, play a critical role in shaping the perceived quality of virtual ritual experiences. By integrating neutrosophic logic into the assessment process, the study goes beyond conventional evaluation methods to capture degrees of agreement, uncertainty, and disagreement in user perceptions. This triadic modeling approach is particularly well-suited to religious and spiritual domains, where user responses are often complex, subjective, and context-dependent.

The results of the correlation and regression analysis revealed a strong and statistically significant positive relationship between the use of a virtual reality application and the experience of simulating Islamic rituals among users, with a high correlation coefficient (R = 0.929) and a coefficient of determination (R Square = 0.863) indicating that virtual reality significantly explains the variance in the simulation experience. These findings align with previous studies highlighting the importance of technology in enhancing the user experience in religious practices, such as those by [36], while showing partial divergence from [2] focus on the challenges of AI in religious tourism, although all agree on technology's importance in this domain. Overall, the current study's results confirm the effective role of virtual reality technology in improving the user experience in performing Islamic rituals, offering valuable insights for developers and designers in the field.

The correlation and regression analysis revealed a strong, statistically significant positive relationship between using a VR application for Islamic rituals and user experience (R=0.791, R Square=0.626), confirming the significant impact of the application's features on creating a realistic and immersive experience. This aligns with previous studies [37, 38] on the importance of application quality in user experience, with this study specifically highlighting the impact on simulating Islamic rituals. The findings underscore the crucial role of visual, auditory, and interactive aspects in enhancing realism and emphasize the need for high-quality VR application development for impactful religious and cultural experiences.

The correlation and regression analysis revealed a strong, statistically significant positive relationship between using a VR application for Islamic rituals and the spiritual and psychological impact on users (R=0.807, R Square=0.651), confirming VR's effectiveness in enhancing users' spiritual and psychological state and providing a meaningful simulation experience. These findings partially align with studies [16]; on impactful immersive experiences through technology, while this study specifically focuses on the religious context. The results suggest VR's contribution to a stronger sense of spirituality and connection, improving users' psychological and emotional well-being, emphasizing the importance of high-quality VR development for impactful religious experiences. Overall, the study confirms VR's effective role in enhancing the spiritual

and psychological state in a religious context, offering valuable insights for VR developers and designers.

The correlation and regression analysis indicated a strong, statistically significant positive relationship between using a VR application for Islamic rituals and the enhancement of users' understanding and knowledge (R=0.911, R Square=0.631), confirming VR's effectiveness as an educational tool in this context. This aligns with prior research [37] highlighting technology's role in providing detailed religious information. The study specifically demonstrates VR's impact on users' cognitive aspects within Islamic rituals, offering new insights. The findings suggest that VR applications enhance understanding through interactive and information-rich experiences, enabling better comprehension of the details and importance of these rituals, thus emphasizing the value of high-quality VR development for impactful religious education. Overall, the study confirms VR's effective role in improving knowledge and understanding of Islamic rituals, providing valuable insights for VR developers and designers in creating immersive and impactful educational experiences.

The correlation and regression analysis demonstrated a strong, statistically significant positive relationship between using a VR application for Islamic rituals and enhancing users' understanding and knowledge (R=0.911, R Square=0.631), supporting VR's effectiveness as an educational tool. This aligns with prior research [37] on technology's role in delivering detailed religious information, with this study specifically focusing on VR's impact on users' cognitive aspects within Islamic rituals, offering new insights. The findings indicate that VR applications improve understanding through interactive and informative experiences, leading to increased knowledge of the rituals' details and importance, thus emphasizing the value of high-quality VR development for impactful religious education. Overall, the study confirms VR's effective role in enhancing knowledge of Islamic rituals, providing valuable insights for VR developers and designers in creating immersive and impactful educational experiences.

The results of this study confirm that specific design characteristics of Virtual Reality (VR) applications, namely user interface, audiovisual design, ease of use, and content availability, significantly influence the perceived quality of simulating sacred Islamic rituals. Beyond traditional statistical analysis, the application of neutrosophic logic provided a deeper and more flexible understanding of the experiential and perceptual nuances associated with religious VR simulations.

The inclusion of neutrosophic modeling introduced several advantages:

- It allowed participants to express uncertainty, rather than forcing them into binary categories.
- It enabled the detection of latent cognitive and emotional tensions in how users evaluated sacred elements of the simulation.
- It provided a mathematically grounded, yet human-centered method for evaluating immersive religious technologies.

For example, while the User Interface (UI) was rated highly in terms of truth (T = 0.84), the Visual and Auditory (VA) aspects exhibited a higher indeterminacy score (I = 0.15), suggesting

spiritual or emotional ambiguity in how users perceived the soundscape or visual symbolism of the ritual.This level of nuance is particularly important in religious contexts where spirituality, tradition, and technology intersect.

The study contributes to both the neutrosophic decision theory and the field of VR-based religious simulation by introducing a novel evaluation framework that merges:

- Smart simulation technology,
- Human-centered design, and
- Neutrosophic logic-based reasoning.

This hybrid model can be extended to other domains such as religious tourism, heritage preservation, and ethical AI systems in culturally sensitive applications.

Despite its contributions, the study has limitations. The neutrosophic values were self-reported, which may introduce subjectivity. The study focused exclusively on Islamic rituals; thus, generalizability to other faith-based VR simulations requires caution. Additionally, while the neutrosophic model adds analytical richness, its computational complexity increases with larger sample sizes and feature sets.

7. Recommendations:

Based on the study results, the researcher recommends the following:

1) **Develop specialized virtual reality applications for Islamic rituals**: Based on the strong positive impact of VR applications on user experience in simulating Islamic rituals, it is recommended to develop specialized applications focusing on immersive and realistic experiences with attention to visual, auditory, and interactive quality, as well as including detailed and comprehensive information to enhance user knowledge and understanding.
2) **Provide accessible virtual reality applications for Muslims unable to perform the rites:** Given the effectiveness of VR applications as a valuable educational tool for this group, it is recommended to offer them free of charge or at a nominal cost, considering availability in different languages and providing technical support and user training to ensure maximum benefit.
3) **Conduct further research on the impact of virtual reality on users' spiritual and psychological state:** Despite indicating a positive impact, more research is needed to

   deepen understanding of this long-term effect, identify influencing factors, and provide recommendations on how to use VR to enhance users' spiritual and psychological well- being.
4) **Develop quality standards for virtual reality applications used in simulating Islamic rituals:** Given the importance of application quality in enhancing user experience, it is recommended to establish quality standards covering visual, auditory, and interactive aspects, information accuracy, ease of use, and security.

5) **Provide training for developers and designers on how to develop effective virtual reality applications for Islamic rituals:** To ensure the development of high-quality VR applications, specialized training is recommended, covering user experience design, the development of visual, auditory, and interactive aspects, and the inclusion of accurate and comprehensive information about Islamic rituals.
6) **Conduct further research on the use of virtual reality in religious education**: Beyond simulating rituals, VR can be used in other areas of religious education such as teaching Islamic history, Arabic language, and Quran interpretation; therefore, more research is recommended to identify best practices and recommendations in this field.
7) **Design a comprehensive virtual reality application for all Islamic rituals**: Based on the strong positive impact of VR applications on user experience, especially in simulating the Sa'i (walking) between Safa and Marwa, it is recommended to design a comprehensive application covering all Islamic rituals, aiming to provide an integrated experience combining realistic simulation with detailed and comprehensive information for each ritual.
8) **For Developers**: Prioritize user-centered design that minimizes ambiguity and enhances emotional immersion, particularly for religious or spiritual applications.
9) **For Educators and Institutions**: Leverage neutrosophic evaluations to assess the effectiveness of VR tools in religious education or community training.
10) **For Researchers**: Extend this framework to other cultural or spiritual simulations, and explore computational implementations of neutrosophic feedback for adaptive VR environments.
11) **For Neutrosophic Systems Community**: Consider further formalizing models that integrate user experience design with neutrosophic decision-making in intelligent systems.

8. Future Research Issues:

Based on the study results, the following future research directions are suggested:

1) **Study VR's impact on enhancing religious values among youth**: Future research should examine how VR applications simulating Islamic rituals can enhance religious values in youth, focusing on identifying which values are strengthened and how VR affects their religious behaviors and attitudes, using both quantitative and qualitative methods.
2) **Analyze factors influencing user acceptance of VR in religious education**: To ensure the success of VR applications in religious education, future studies should analyze the psychological, social, cultural, and technological factors influencing user acceptance, potentially using technology acceptance models like TAM and UTAUT.
3) **Evaluate VR's effectiveness in teaching Islamic rituals to children with special needs**: Given VR's potential for sensory and interactive experiences, future research should evaluate its effectiveness in teaching Islamic rituals to children with special needs,

identifying best practices and developing tailored applications based on their specific

needs.

4) **Study VR's impact on enhancing religious tolerance and interfaith dialogue**: Future research should explore how VR applications can promote religious tolerance and interfaith dialogue through interactive experiences that educate users about other religions and cultures, using both quantitative and qualitative approaches.
5) **Analyze VR's impact on developing practical skills in performing Islamic rituals**: Future studies should analyze how VR applications can help users develop practical skills for performing Islamic rituals like prayer, Hajj, and Umrah, identifying best practices for application development using quantitative and qualitative methods.

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