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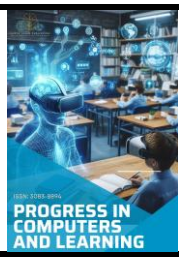

Developing Aesthetic Immersive Experience (AIX) Model using Fuzzy Delphi Method for Virtual Reality Historical Event

Noorazzahrawani Abdul Rani[1], Mohd Ekram AlHafis Hashim[1,*], Muhammad Zaffwan Idris[1], Wandah Wibawanto[2]

[1] Department of Creative Multimedia, Faculty of Art, Computing and Industry Creative, Universiti Pendidikan Sultan Idris, 35900 Tanjong Malim, Perak, Malaysia
[2] Jurusan Seni Rupa (Gedung B5), FBS Universitas Negeri Semarang, Indonesia

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ABSTRACT

The user experience model is an indispensable tool for assessing the quality of immersive virtual reality (VR) technology. The design of the experience-based products involved creative approaches viewing from aesthetic perspectives. Thus, it indicates the need to develop a unifying aesthetic immersive experience (AIX) model with an expert's consent through the Fuzzy Delphi Method (FDM) to appraise the new experience. The model focuses on aesthetic experience and immersive experience constructs and elements; cognitive, perception, and emotional as scrutinised in the literature review. Hence, this paper aims to explain the development of the initial AIX model using FDM for VR historical events. The method implementation commenced with developing a survey of AIX elements using a seven-point linguistic scale, selecting experts, and determining linguistic variables based on the triangular fuzzy number, fuzzy scale level, defuzzification process, ranking, and formulation. The defuzzification value of each item consisting of the required threshold (d) value < 0.2 and percentage > 70% of expert consent to determine consensus on the survey items, as the alpha-cut (α-cut) value of ≥ 0.5 to select the AX and IX elements in the model. The d value for the accepted elements ranges between 0.109 and 0.191, and the α-cut value is shown between 0.627 and 0.873. After the defuzzification stage, the formulation instigates, which requires merging, combining, withdrawing, and renaming constructs and elements to denote the AIX model contextually. Thus, a consensus has been reached, with twelve constructs with respective twenty-five elements, which were then formulated into three constructs and sixteen elements to form the initial AIX model to develop virtual reality historical events. The findings create a new intervening input in creative fields and immersive experience design for virtual exploration in enhancing art and history education.

1. Introduction

The Human-Computer Interaction (HCI) field entails post-phenomenology studies to unfold the interactions' ontology, and recently, it has focused on the effect of immersive and artificial

* *Corresponding author.*
E-mail address: ekram@fskik.upsi.edu.my

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intelligence. The study extends to human-technology interaction, which reveals the relations between human beings and technological artefacts, arranging the numerous ways technologies help form relations between human beings and the world. The phenomenon is assessed using philosophical analysis with empirical investigation. In this case, technologies are approached as mediators of human experiences and practices [1-3]. Therefore, the interaction mechanism will define the type of relationship that facilitates user experience design. The immersive VR systems progressively evolve duly to their technological aspects. VR technological elements are emphasised to meet content needs. VR conceptual framework underscores enhancing the user's sense of presence, immersion, and engagement within a virtual environment [23,24]. VR interventions could result from the relationship between constituents, namely humans, the world, the mediator, the user, and the environment, caused by multi-interaction [22,25].

Virtual reality (VR), a user experience-driven product, is claimed to evoke an immersive experience (IX) among users. VR intervention uses a pragmatic approach, which will form a relationship called 'reflexive intentionality' or recognised as immersion. Afterward, the virtual environment of the VR application is the stimulus that stimulates a sense of immersion. A virtual environment consists of virtual objects, namely graphics, 3D models, animated objects, programming algorithms, and interaction. VR interaction involves vision, auditory, gesture, and haptic. User undergoing VR-mediated experience interact in a virtual environment, explicitly feeling immersion, which changes behaviour, feelings, and attitudes, impacting how they relate to their world.

Thus, the VR experience study involves contemplating one's experiences when ratiocinating on the immersion phenomenon, which is associated with a sense of presence, self, or place. Virtual museum exploration, explicitly using a VR headset or head-mounted display (HMD), creates an immersive virtual museum experience that constantly measures associated with the level of presence and immersion [4-7]. VR interaction allows a mediation process in real-time, copying natural gesture movement, manipulation of virtual objects like physical (real) objects, and instantaneous response to induce a sense of reality, a sense of being there, a sense of location, a sense of the properties of the real world and sense of movement around virtual space. Besides, context and content information are delivered through a narrative approach. Hence, the user will feel immersed. Thus, most of the studies on virtual museum exhibitions mention immersion experience. A high degree of immersion can bring a certain degree of pleasure, and a moderate degree can also improve cognitive efficiency [8].Nevertheless, defining IX involves explaining the cognitive processing of information, acquired perception, and emotional valance and arousal effect when assessing the virtual environment.

A creative approach using computer-generated imagery (CGI) and 3D modelling technology drives the development of virtual heritage. 3D reconstruction of a historical site and inhabitant of the past decade, century, or even millennium years combined with CGI liven up history collections such as ancient paintings, statues, or monuments with a realistic visual look to create a more captivating virtual heritage. Thus, digitizing artworks such as ancient paintings into VR will make them "alive" in virtual galleries, purposely intensifying the aesthetic experience and enhancing art appreciation. Besides that, VR applications are created for the visualisation of events [9], history education [10] and interpreting stories or concepts [11].

The composition of the virtual environment, whether in a cultural and historical-based context or another, is perceived as an aesthetic object requiring aesthetic evaluation. The actual historical event materials are transformed into an immersive narrative art form, shifting visitor assessment into a new dimension involving aesthetic and immersive perception. Upon entering the virtual environment, the user psychologically assesses the realism, beauty, or authenticity of the object that appears to the user. User cognition and perception start by evaluating the virtual objects and deciding

whether to feel fascinated. Therefore, when the user is assessing the beauty of an object, they are experiencing an aesthetic experience (AX) [12,13]. The virtual object has become an aesthetic object or pleasure to the user. Consequently, if the virtual environment is visually appealing, the user will progressively experience the virtual world, reach a fascinating state, become immersed, and feel enjoyment. The emotions and feelings aroused are classified as aesthetic emotions [14,15]. Emotion becomes the process's output when users value and appreciate the virtual historical representation and narrative experience. Thus, aesthetic emotions are used as a measurement dimension of this VR historical event (VRHE) experience.

VR in culture and history learning has gained traction for immersive heritage experiences. Its multisensory interaction allows the adoption of natural interaction that replicates real-world situations. Immersive VR headsets and handhelds bring a fully 360-degree atmospheric view, 3D space, 3D realistic manipulated objects, and multisensory channel input and output, giving a high degree of interactivity [16-18] and causing an entire embodiment. This type of embodiment could change visitors' perceptions and judgements of virtual historical events. The user or visitor's role as a spectator could become a 'spectactor' in the virtual world without changing the worldly social subjectivity of visitors. Rahaman (2018) [19], in his PrEDiC conceptual framework for interpreting digital heritage, highlights four aspects of conceptual levels; a. presentation, b. embodiment, c. cultural learning, and d. dialogic-interaction. Suh & Prophet, (2018) [20] conclude that individual differences may have moderating effects on immersive system features, as well as on users' cognitive and affective reactions, and users' cognitive and affective reactions and the outcomes of immersive technology use.

Historical events are conceived of historical and culturally significant information such as the original site and inhabitant, period, historical figure, and storyline. Telling a virtual historical story requires visualisation and composition process. Those processes involve designing character and personality, set or scene, dialogue, sound, cinematographic, and semiotic elements within story length without eliminating the design elements such as fidelity, authenticity, authority, and realism [21,22]. The designs become virtual representations and are known as virtual heritage. Furthermore, VR narration techniques can be applied in VR Historical Event design, such as user interface, visual configuration, audio configuration, locomotion mode, duration, mode of interaction, and mode of feedback [23-25]. Notably, at the creation stage, Aylett's [26] storytelling approach becomes a guideline for the storification process and the role of the user; narrativisation of virtual historical event content. Main VR features are immersive and interactive, considering user interaction with the virtual environment and avatar; thus, creating their story plot leads to implementing the participative narrative form [27].

Furthermore, previous studies show that the evaluation of VR experience occurs after the user has undergone psychological assessment [28] and phenomenological exploration [29,30] within the virtual world. Nevertheless, to assess attainment, both IX and AX will lead to measuring the user's sense of presence [31], appraisal [32,33], appreciation [28], and meaning [34], especially for the immersive historical-based virtual environment. Thus, immersion and aesthetic experience affect the audience's emotional experience when viewing the exhibition [8].

Appraising AX and IX scores against VR historical events depends on what elements evoke the user's emotion. In VR, several IX elements react to VR products based on relationships among UX components: flow, presence, usability, skill, emotion, immersion, engagement, judgement, technology adoption and experience consequence [35]. Conversely, the cognitive shift occurs in a historical event when a user perceives and interacts with the historical event and produces an AX element. However, many AX and IX elements need to be considered when measuring AX and IX in VR historical events, as outlined by Chrysanthakopoulou *et al.,* (2021) [36], such as multi-sensorial

interactions, free exploration, detailed virtual environment, auditory aspects, animated characters, weather and lighting conditions, laws of physics, force feedback to the user and game-like environment. Correspondingly, the virtual environment in VR is an artistic medium [17] that reveals a sense of place, a sense of being there, realistic representation, a sense of agency, levels of agency, interaction method, types of navigation structure, travel techniques, wayfinding aids, self-transformation, enactment in VR and immersive journalism [37].

Based on the literature review, there was no element of AX in the VR product. Even though studies were done using aesthetic objects as its subject and vice versa, no IX element in the art forms was found, despite using VR as its medium. Several studies involving VR products integrating arts as their subject matter were evaluated in IX terms such as immersion, presence, interaction, agency, and transformation. Developing of a VR system uses the user experience approach [38] to design and evaluate the effectiveness of VR products [39]. However, the evaluation is limited from a design context, involving only formalistic elements and discarding the emotional factor.

In essence, the richness of the VR experience cannot be adequately captured through a single dimension of assessment. Therefore, historical events, IX, AX, and emotion become vital components in immersive virtual museums. Consequently, there is a pressing need for a multifaceted evaluation framework to leverage the quality of VR applications. Despite this, no researcher has underscored the importance of adopting an assessment by unifying two or more dimensions derived from the VR experience. Previous research focuses only on separately evaluating the AX and IX of VR experience.

The design and evaluation of VR product effectiveness should not be limited to the UX approach [40]. In short, single-dimension evaluation does not adequately capture the UX in VR. In this case, a multidimensional evaluation framework is required to measure the quality of VR applications. Among the IX features that are featured in VR are a sense of reality, sense of presence, sense of culture, immersion, interactivity, level of detail, and meaningful. In contrast, AX features in historical events are accuracy, realism, fidelity, relevance, reflection, relaxation, mindfulness, harmony, and storytelling clarity. Empirically, there is a huge theoretical gap between AX and IX when managing art and technology-based products like VR historical events, so that needs a solution by developing a new integrative AX and IX model unifying AX and IX elements.

The literature study reveals that Hashim (2022) [41] has developed the Hexagon Aesthetic User Experience (AUX) model. The synergised AUX model, which integrated components and elements between an aesthetic experience (AX) and user experience (UX) from both disciplines, was applied to Augmented Reality Comics (AR Comic) or AR-based products and evaluated using aesthetic emotion items. Hence, this study will be based on the AUX model, using the Fuzzy Delphi Method (FDM) [42] and emotions dimension to unify AX and IX for VR-based products. This research aims to develop an integrative aesthetic immersive experience (AIX) model for VR history-based applications using FDM [43,44].

In this study, aesthetic experience in VR formulated by Markovic (2012) [13], Diodato, (2022) [45], Brinck, (2018) [46], supported by Moens, (2018a) [47], Redies (2015) [48] and Leder et al. (2014) [49]. Diodato (2022) [45] suggested how users achieve attention through VR interactivity. Brinck, (2018) [46] describes the emergence of aesthetic experience, namely empathy, engagement and entrainment, based on the reciprocal interaction between viewer perception, emotion, action, and motion toward the artwork. Thus, users could encounter peak-shift phenomena while viewing culturally significant elements and evaluate the object-event and its relationship to spacetimes in a virtual environment. Admittedly, Moens, (2018a) [47] explained that viewer cognition at the macroperceptual level uses cultural conception to interpret cultural and historical environment context.

In brief, the integration of IX and AX in VR historical events is conducted for several reasons: 1) VR, being an HCI-based product, aligns closely with IX as a measurement method, whereas narrated historical events are aesthetic objects, necessitating AX as their measurement method. 2) IX assesses conception, visualisation, interactivity, interaction, and presence, while AX involves feelings, content, context, and expert appraisal. 3) IX deals with technology products and interactivity, while AX pertains to aesthetic objects and requires appreciation. Although VR is designed to enhance information, it also serves as an artistic and imaginative stimulus, enriching the emotional experience in VR historical events [15].

Therefore, this study's objective is to explain the development of the initial AIX model using FDM. FDM employs fuzzy logic to address uncertainty and ambiguity in expert judgments, facilitating consensus in complex decisions [50]. The central formulation of the model development is by unifying constructs of AX and IX in the context of Immersive Media Art. Hence, this model was developed using the FDM to achieve the research aim by gaining consensus among a panel of experts [51]. For AIX development, the theoretical framework is illustrated in Figure 1. The AIX model can be used among researchers, VR developers, and museum institutions to develop and evaluate VR historical-based applications.

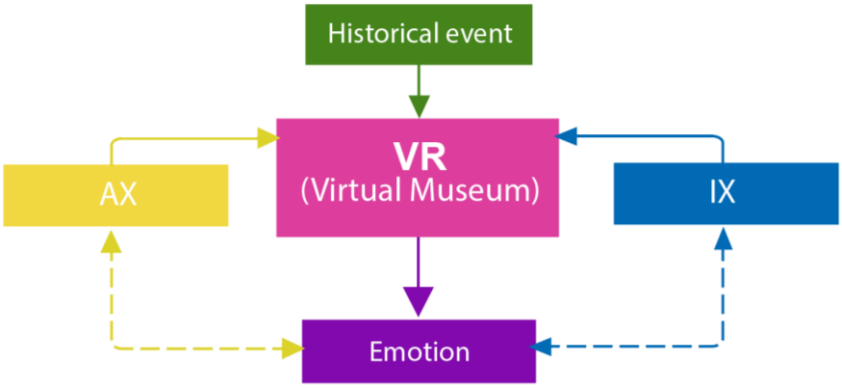

Fig. 1. Relationship between aesthetic experience, immersive experience and emotion in VR historical event.

2. Methodology

This study used the Fuzzy Delphi Method (FDM) as an analytical method for the decision-making process. Triangulation statistics is employed to assess the degree of agreement among experts, which determines the distance between consensus levels within the experts to achieve consensus on the constructs and elements of an AIX model. Despite this, in the Need analysis phase, methodological review (MR) is the first step to assess AX and IX elements to ensure accomplishment in the defuzzification process, which is then arranged for the formulation stage. The research methodology process is illustrated in Figure 2.

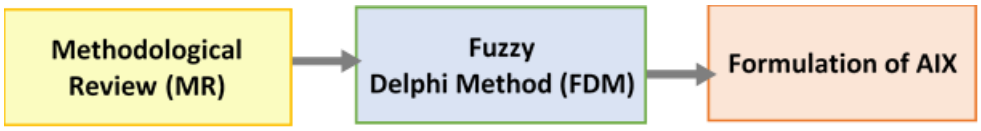

Fig. 2. Initial AIX development process

The MR was conducted on AX and IX models in both significant areas of knowledge as the basis for designing of the AIX model. Models were analysed by identifying problems, work-flow, processing

system, and output of both models, along with the concept of emotional theory, VR, a virtual museum and historical events. Thus, after the MR investigation, fourteen (14) constructs and fifty (50) elements are identified for FDM execution, listed in Table 1.

Table 1
The constructs and elements of AX and IX

AX	
Construct	**Element**
1. Motivation	Degree of attention, encouraging
2. Compositional	Feeling of discovery, empathy, formal, mindfulness, symbolic
3. Creativity	Self-expressive, creative, eager to explore new things.
4. Meaningfulness	Personal value, relevant, historic value
5. Intuitiveness	Human likeness, naturalness, materiality, functionality
6. Imaginative	Non-narrative, imaginary
7. Efficiency	Time, degree of interactivity
IX	
Construct	**Element**
1. Immersive	Sense of presence, sense of location, sense of oneself, relaxation, memorable
2. Narrative	Nonlinear, real-world event, dynamic, sense of awareness, situational context
3. Interactive	Multi-sensorial, free exploratory, playfulness, feeling of union, action, enjoyment
4. Realism	Fidelity, details, law of physic, sense of cultural
5. Storytelling	Dramatic, fantasy
6. Informative	Cultural significant, originality, supplementary information, intention to revisit
7. Manipulative	Zooming, rotating, tangibility

2.1 The Fuzzy Delphi Method (FDM)

The FDM process emphasises the importance of incorporating expert reviews, and focus groups [52] to ensure the successful gathering of concise and reliable data. Thus, the FDM questionnaire was developed by amalgamating insights from a literature review, researcher experience, expert input, feedback from focus groups and pilot testing. The implementation steps of FDM involve a) selection of experts, b) determination of linguistic variables based on the triangular fuzzy number, c.) fuzzy scale level, d) expert consensus, e) defuzzification process, and f) ranking.

Experts were carefully selected to ensure their understanding of the significance, requirements, and priorities of the variables measured using linguistic variables. In the FDM approach, researchers can conduct in-person meetings with experts to facilitate discussions and address any potential issues related to the items. Each expert in this study had the freedom to provide comments, improve existing items, or suggest new ones. The questionnaire was returned after the assessment process was completed.

The FDM consists of three primary processes; a) triangular fuzzy number, b) defuzzification, and c) ranking. The triangular fuzzy number represents values m1, m2, and m3, where m1 is the minimum value, m2 is a reasonable value, and m3 is the maximum value. The aim is to establish a fuzzy scale for converting linguistic variables into fuzzy numbers, with higher values on the scale corresponding to more precise data. Conversely, the defuzzification involves assigning precise values to fuzzy numbers within the 0 to 1 range, setting a significance threshold below 0.2. When the threshold value is significant, measurement items or constructs are considered acceptable when expert consensus exists. Simultaneously, the ranking process is applied to arrange constructs and items based on the chronological order of their occurrence, as determined by expert consensus on the main and ultimate constructs.

2.2 Participant

The focus of the FDM is on the development of an aesthetic immersive experience model for VR historical event, hence views and opinions from panel of experts in creative multimedia, new media art, history and museum will be employed. The criterion of selection of the experts for the panel is crucial as they are the central of reaching the consent. An expert is an individual who has the requisite knowledge and experience to engage actively in a Delphi process. The assigned panel of experts is responsible for validating constructs and elements in the preceding MR process.

Due to the heterogeneity of these experts, a total of ten experts would be adequate to gather empirical data [49]. Concerning this, ten experts are appointed; five representing creative multimedia and five others representing VR. Experts' qualifications are determined by field and experience criteria, as well as their expertise and contributions in their field. Experts' qualifications are determined by having more than five years of experience in the creative multimedia field and a creative multimedia project or programme involvement or teaching experience in the creative multimedia subjects. For VR experts, the criteria considered involvement in the new media industry and acknowledged expertise. Due to the heterogeneity of these experts, a total of ten experts would be adequate to gather empirical data [53].

Based on the discussion and reference of the literature review, the expert's selection for this Delphi phase involved a) an academician who is an expert in the discipline of creative multimedia, b) museum professionals or history experts who are actively contributing to museum exhibitions in contemporary and conventional ways, c) new media industry players who produce VR as their main product and, an academician who is an expert in VR or immersive technology.

2.3 Instrument

The instrument in this study was an expert survey developed from the constructs and elements of AX and IX, which emerged from the MR analysis of the previous theory, framework, and model. Ten experts were briefed and distributed the survey form for the expert survey. They were asked about the possibilities for contextually functional elements in developing the VR historical event. The questionnaire consisted of 50 items or elements from 14 constructs using a seven-point Likert scale. Each element's contextual and technical description is also provided to facilitate experts answering the survey for more concise and reliable decisions. The surveys were collected from experts via online submission after two weeks.

2.4 Data Analysis

The survey with ten experts was analysed using the FDM application of Microsoft Excel software. The FDM was conducted according to the following steps:

2.4.1 Step 1: Determining the linguistic scale

The linguistic scale is a Likert scale with the addition of fuzzy numbers [54]. In order to tackle the challenge of uncertainty among experts, three fuzzy values are assigned to each response, forming a triangular fuzzy number shown in Figure 3. Within this number, m1 represents the minimum value, m2 represents the intermediate value, and m3 denotes the maximum value. These values, m1, m2, and m3, are fuzzy numbers within the 0 to 1 range. Consequently, for each Likert scale response, three values are generated. Table 2 illustrates the fuzzy numbers for a seven-point linguistic scale.

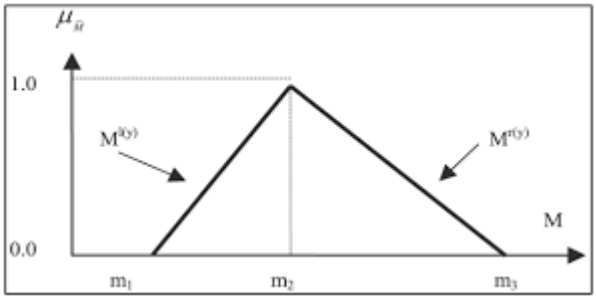

Fig. 3. Triangular fuzzy number [54]

Table 2
Fuzzy numbers for a seven-point linguistic scale

Linguistic variables	Fuzzy scale
Extremely disagree	(0.0,0.0, 0.1)
Strongly disagree	(0.0, 0.1, 0.3)
Disagree	(0.1, 0.3, 0.5)
Moderate	(0.3, 0.5, 0.7)
Agree	(0.5, 0.7, 0.9)
Strongly agree	(0.7, 0.9, 1.0)
Extremely agree	(0.9, 1.0, 1.0)

2.4.2 Step 2: Computing the average fuzzy number

The average fuzzy number is calculated by identifying the average responses for every fuzzy number [55].

2.4.3 Step 3: Identifying threshold value 'd'

The threshold value is crucial to determine the consensus level among experts. The 'd' value is analysed in the application is guided by the following formula:

$$d(\bar{m},\bar{n}) = \sqrt{\frac{1}{3}\left[(m1-n1)^2 + (m2-n2)^2 + (m3-n3)^2\right]}$$

The experts are considered to have achieved a consensus if the threshold value is less than or equal to 0.2 [56], and the overall group consensus should be equal to or more than 70% [57]. Otherwise, the FDM survey should be repeated until a consensus is achieved.

2.4.4 Step 4: Identifying alpha-cut level (α-cut)

In order to select elements for a model, most studies used the α-cut level, which equals 0.5, as the range of the fuzzy number is between 0 and 1 [58]. Thus, the α-cut 0.5 is used as a cut level to select the elements for the AIX model. Elements above 0.5 will be selected, and those below 0.5 will be omitted.

2.4.5 Step 5: The defuzzification process

In order to justify experts' consensus on the elements of the AX and IX in the model, a defuzzification is required. Defuzzification is a technique to convert fuzzy numbers into real numbers. The defuzzification outcome is the fuzzy score for each questionnaire item, which is calculated using the following equation:

$$A = 1/3 * (m1 + m2 + m3)$$

2.4.6 Step 6: Ranking the elements of the model based on fuzzy score

The elements are ranked in order to show their priority in the model. The element with the highest fuzzy score is ranked highest in priority [59]. The ranking process involves organizing, managing, removing, and integrating constructs and elements based on their priority and sequential order. Hence, it establishes the formulation of the AIX model. However, it is crucial to establish the definitions of each construct and element through expert consensus, MR, and literature review.

3. Results

After administering the FDM questionnaire, the data collected was analysed according to the FDM steps. The result of the FDM process is shown in Table 3.

3.1 The Threshold Levels

In order to determine consensus among the experts on each item in the questionnaire, the threshold value (d) was calculated based on the experts' responses to the seven-point linguistic scale on the FDM questionnaire. The d value is equaled to or more than 0.2 and percentage more than 70% of expert consensus, shown that the required consensus was reached. Hence, since consensus had been achieved, there was no need to repeat the FDM.

3.2 The Alpha-Cut (α-Cut)

From the α-cut analysis, it concluded that the experts thought that the AX constructs are Motivation, Compositional, Creativity, Meaningfulness, Intuitiveness, Imaginative, and Efficiency. Also, the AIX model should include IX constructs of Narrative, Interactive, Realism, Informative, and Manipulative. The decision to include these constructs depends on accepted elements, which was determined using the α-cut level. As determined earlier, the accepted value for α-cut was 0.5. The results in Table 3 show all the items that achieved the required acceptance level. The maximum value was obtained for creative, with a value of 0.873, and the minimum was for formal, at 0.627. Based on the results, twelve (12) constructs and twenty-five (25) elements were selected for inclusion in the AIX model.

Table 3
Experts' agreement based on fuzzy scale

Construct	Element	Percentage	Threshold value	Fuzzy score	Consensus	Ranking
Motivation	Degree of attention	100%	0.157	0.830	Accept	2
	Encouraging	100%	0.145	0.857	Accept	1
Compositional	Feeling of discovery	100%	0.145	0.820	Accept	1
	Empathy	70%	0.269	0.627	Accept	5
	Formal	90%	0.191	0.627	Accept	4
	Mindfulness	80%	0.162	0.757	Accept	2
	Symbolic	80%	0.144	0.740	Accept	3
Creativity	Self-expressive	90%	0.170	0.773	Accept	3
	Creative	100%	0.118	0.873	Accept	1
	Eager to explore new things	100%	0.169	0.813	Accept	2
Meaningfulness	Personal value	100%	0.109	0.677	Accept	3
	Relevant	100%	0.140	0.793	Accept	1
	Historic value	90%	0.229	0.790	Accept	2
Intuitiveness	Human likeness	70%	0.214	0.657	Accept	4
	Naturalness	80%	0.179	0.683	Accept	3
	Materiality	100%	0.106	0.750	Accept	2
	Functionality	70%	0.201	0.753	Accept	1
Imaginative	Non-narrative	70%	0.188	0.737	Accept	2
	Imaginary	100%	0.155	0.803	Accept	1
Efficiency	Time	90%	0.169	0.673	Accept	2
	Degree of interactivity	60%	0.291	0.740	Reject	
Immersive	Sense of presence	80%	0.229	0.773	Accept	2
	Sense of location	80%	0.216	0.780	Accept	1
	Sense of oneself	90%	0.218	0.670	Accept	4
	Relaxation	40%	0.373	0.653	Reject	
	Memorable	60%	0.247	0.743	Reject	
Narrative	Nonlinear	60%	0.185	0.730	Reject	
	Real-world event	80%	0.227	0.790	Accept	2
	Dynamic	90%	0.176	0.827	Accept	1
	Sense of awareness	70%	0.217	0.717	Accept	5
	Situational context	80%	0.162	0.757	Accept	3
Interactive	Multi-sensorial	70%	0.233	0.733	Accept	5
	Free exploratory	70%	0.201	0.753	Accept	3
	Playfulness	80%	0.227	0.790	Accept	2
	Feeling of union	80%	0.144	0.740	Accept	4
	Action	70%	0.166	0.720	Accept	6
	Enjoyment	100%	0.155	0.867	Accept	1
Realism	Fidelity	90%	0.145	0.747	Accept	1
	Details	70%	0.166	0.720	Accept	3
	Law of physic	70%	0.286	0.677	Accept	4
	Sense of cultural	40%	0.305	0.747	Reject	
Storytelling	Dramatic	70%	0.233	0.733	Accept	1
	Fantasy	80%	0.268	0.673	Accept	2
Informative	Cultural significant	70%	0.164	0.750	Accept	2
	Originality	50%	0.261	0.707	Reject	
	Supplementary information	50%	0.249	0.737	Reject	
	Intention to revisit	80%	0.253	0.760	Accept	1
Manipulative	Zooming	80%	0.167	0.720	Accept	1
	Rotating	60%	0.268	0.663	Reject	
	Tangibility	60%	0.265	0.710	Reject	
Motivation	Degree of attention	100%	0.157	0.830	Accept	2
	Encouraging	100%	0.145	0.857	Accept	1

3.3 Defuzzification and Ranking

The triangulation analysis will eliminate and accept elements and constructs. The rejected elements are discussed based on previous theories, models and concept reviewed during MR. Next, the selected twenty-five (25) elements were ranked for design and development priority in the AIX model. This was done by referring the fuzzy score where the highest ranking was for element with the highest fuzzy score (Table 3). The elements were ranked within twelve (12) referral constructs namely; Motivation, Compositional, Creativity, Meaningfulness, Intuitiveness, Imaginative, Efficiency, Narrative, Interactive, Realism, Informative, and Manipulative. Table 4 also revealed the rankings of the elements according to constructs.

Table 4
The elements' ranking in the AIX model

Before FDM		After FDM
Constructs	Elements	Elements (Ranked)
1. Motivation	Degree of attention, encouraging	1. Encouraging 2. Degree of attention
2. Compositional	Feeling of discovery, empathy, formal, mindfulness and symbolic	1. Feeling of discovery 2. Mindfulness 3. Symbolic 4. Formal
3. Creativity	Self-expressive, creative, eager to explore new things	1. Creative 2. Eager to explore new things 3. Self-expressive
4. Meaningfulness	Personal value, relevant, historic value	1. Relevant 2. Personal value
5. Intuitiveness	Human likeness, naturalness, materiality, functionality	1. Materiality 2. Naturalness
6. Imaginative	Non-narrative, imaginary	1. Imaginary 2. Non-narrative
7. Efficiency	Time, Degree of interactivity	1. Time
8. Immersive	Sense of presence, sense of location, sense of oneself, relaxation, memorable	-
9. Narrative	Nonlinear, real-world event, dynamic, sense of awareness, situational context	1. Dynamic 2. Situational context
10. Interactive	Multi-sensorial, free exploratory, playfulness, feeling of union, action, enjoyment	1. Enjoyment 2. Feeling of union 3. Action
11. Realism	Fidelity, details, law of physic, sense of cultural	1. Fidelity 2. Details
12. Storytelling	Dramatic, fantasy	-
13. Informative	Cultural significant, originality, Supplementary information, intention to revisit	1. Cultural significant
14. Manipulative	Zooming, rotating, tangibility	1. Zooming

The experts agreed that total of twelves (12) constructs and twenty-five (25) elements should be concluded in the initial AIX model and forwarded to next stage; model formulation process. The final constructs and elements are illustrated in Figure 4.

Fig. 4. Constructs and elements of AIX after FDM

3.3.1 The rejected constructs and elements

The FDM analysis found that no construct from AX has been rejected. However, two constructs from IX have been rejected, immersive and storytelling, because their elements have not met one of the FDM conditions. All rejected constructs and elements are discussed below.

Immersive construct is deemed to be a vital construct. From the findings, all immersive elements gained expert consensus. However, the elements had a d value that exceeded 2.0, which does not comply with the condition. Hence, the elements were rejected. The elements are; sense of presence (with 80%, d value 0.229, fuzzy score 0.773), sense of location (with 80%, d value 0.216, fuzzy score 0.780), sense of oneself (with 90%, d value 0.218, fuzzy score 0.670), relaxation (with 40%, d value 0.373, fuzzy score 0.653), and memorable (with 60%, d value 0.247, fuzzy score 0.743).

Immersive is subjective to the user's mental state related to cognition and perception. The user could already be immersed when entering the virtual world, where the imaginary processing has started, if there is no anxiety and confusion or negative appraisals, which influence abortive self-protection [60]. The only argument could be about the types of immersion, and their level of immersion should be determined in order to assess the user's presence in VR historical events precisely. Whether immersive was included or not, it did not weaken the structure of the model. Besides, the accepted elements, such as the feeling of union from the interactive (IX) construct, become vital to represent the immersion dimension in AIX products.

While storytelling construct with dramatic element (with 70%, (d) value 0.233, fuzzy score 0.733) and fantasy (with 80%, (d) value 0.268, fuzzy score 0.673) have been rejected. Storytelling construct

and its elements; dramatic and fantasy can be replaced by non-narrative element of narrative construct, as the narrative in VR could not be identified as a structured narrative [61].

Moreover, twenty-five (25) elements have been rejected out of fifty (50) elements. Only nine (9) elements have been rejected by expert consensus with a percentage below 70%, which are the degree of interactivity (60%) from efficiency, relaxation (40%) and memorable (60%) from immersive, nonlinear (60%), sense of cultural (40%) from realism, originality (50%) and supplementary information (50%) from informative, and rotating (60%) and tangibility (60%) from manipulative.

Whereas the other sixteen (16) rejected elements had fulfilled the consensus percentage condition, however having the threshold (d) values above 2.0. This employs the alpha cut formula, where the alpha number value should be less than 0.2. Any element exceeding the threshold value is excluded as it indicates a lack of consensus among the experts. The AX elements are empathy (d value 0.269) of compositional, historic value (d value 0.229) of meaningfulness, human likeness (d value 0.214) and functionality (d value 0.201) from intuitiveness. While elements from IX are; sense of presence (d value 0.229), sense of location (d value 0.216), sense of oneself (d value 0.218) from immersive construct, real-world event (d value 0.227) and sense of awareness (d value 0.217) of narrative, multi-sensorial (d value 0.233), free exploratory (d value 0.201) and playfulness (d value 0.227) from interactive construct, law of physic (d value 0.286) from realism, dramatic (d value 0.233) and fantasy (d value 0.233) from storytelling and finally intention to revisit (d value 0.253) from informative. In addition, there are no elements with a fuzzy score below 0.5. The lowest fuzzy score value is 0.627 for elements of empathy and formal. Most of the elements rejected showing expertise decision towards its concept within VR historical event context or may the elements hold redundant meaning with other elements.

3.4 The Formulation of AIX Model

The formulation process of the AIX model is a structured process preliminary with the MR, the assortment of AX and IX constructs and elements, the integration of models and theories, and obtaining expert consensus through the FDM scientific process. The acceptable constructs and elements will be organized through accumulation, merging, altering and renaming to determine propriety following VR historical events. The ranking of each element will also be studied as a guideline for merging, accumulating or altering the constructs and elements, as well as obtaining the AX and IX models and theories from the MR process carried out. Also, involved in discussions with FDM experts to validate AIX constructs and elements.

Table 5 below shows the accepted constructs and elements of AX and IX. Only one AX construct, Efficiency, has one element after the FDM process, while two constructs from IX, Informative and Manipulative, have one element. In such cases, one element is not lucrative enough to grow a strong correlation between constructs in developing any model. Thus, the constructs will undergo a process of combining, merging, altering, and renaming.

For AX, Efficiency construct with one element, time and for IX, Manipulative construct with its element Zooming are added to Interactive construct. Interactive has received time as it represents the length of time the user perceives or interacts toward content within exposure interval either for current or after the interaction that influences the emotional reaction. Also, time reflects the historical era or period of the current historical moment in the history timeline. Zooming is a type of interaction that is applicable in a virtual environment to facilitate interactivity. Hence, another IX construct, Informative with its element Cultural Significant is added to the Realism construct. Realism has received Cultural Significant since realistic of historical-based content should induce awareness of the real cultural and historical significant within the virtual environment through cognisance of the

original site, a particular socio- cultural, racial, and ethnic groups, as well as gender and age. Thus, Realism has Cultural Significant, Fidelity and Details.

Table 5
The acceptable construct and element from the expert consensus of AX and IX

Component	Construct	Elements
AX	1. Motivation	Encouraging, degree of attention
	2. Compositional	Feeling of discovery, mindfulness, symbolic, formal
	3. Creativity	Creative, eager to explore new things, self-expressive
	4. Meaningfulness	Relevant, personal value
	5. Intuitiveness	Materiality, naturalness
	6. Imaginative	Imaginary, non-narrative
	7. Efficiency	Time
IX	8. Narrative	Dynamic, situational context
	9. Interactive	Enjoyment, feeling of union, action
	10. Realism	Fidelity, details
	11. Informative	Cultural significant
	12. Manipulative	Zooming

Compositional has received Relevant and Personal Value from Meaningfulness and Materiality from Intuitiveness. Then, Compositional is combined with Realism and renamed as Captivating. The merger process is still being conducted. Particularly, Materiality and Details are merged into Fidelity as those elements have the same contextual meaning. Materiality refers to the pragmatic features or artistic matters of an object concerning material rendering effects represent accurately to the actual material, while Details refer to as level of accuracy of visual mapping, which deals with art elements; colour, form, and texture in making sure the visual look of object is clear and precise depicting the real object. Those definite features portray the degree of fidelity and level of authenticity that induce a sense of place, which heightens the sense of realism to delineate realism.

Founded in MR, Relevant describes awareness towards the meaningful and relevance of the content, involves coping probable and reliable upon the virtual environment conforming the real-world objects. Fidelity and Relevant are the two most vital matters discussed related to virtual heritage composition. The degree of fidelity and level of authenticity associated to contextually relevant which objectively use to measure successfulness in representation for a virtual reconstruction site, in this case a historic site. The intertwining of relevant fidelity and authenticity at various visualisation levels will affect the sense of place and support the meaning interpretation of the original inhabitant area.

The composition of a historical-based virtual environment should preserve culturally significant conformation. It should also meet the cultural and historical weight requirements of the historical event. The user will acknowledge that the virtual world belongs to the original site/location, a particular socio-cultural, racial, and ethnic group, as well as gender and age. Feeling aware of the cultural and historical significance within the virtual environment will evoke a sense of immersion.

Personal values will influence the exploration of the virtual environment. Personal value is an awareness of the historical content's meaning, reflecting personal self-meaning. Users might have inner emotional states or interpersonal relationships to appraise the narrative. Hence, will understand the basic meaning of the content. In addition to dense Captivating, the Feeling of discovery is merged into Eager to explore new things in the Creativity construct, while Mindfulness is merged into the Degree of attention in the Motivation construct. As a result, Captivating comprises Cultural Significant, Fidelity, Symbolic, Personal Value and Formal.

For Motivation, it has received Mindfulness from Compositional and merged with a Degree of attention as it has a similar contextual meaning. Mindfulness refers to as connectedness and unity with virtual or artificial people, life, nature, and the like. Also, it reflects attention or focus on the virtual world from a larger perspective, losing the immediate sense of time and space.

In Creativity, Self-expressive is merged into Creative as it represents a similar contextual meaning. The Feeling of discovery is merged into Eager to explore new things and renamed Sense of Exploration. The merger was conducted as both elements showed openness to experience new things. Eager to explore new things shows a user's willingness to experience new things and appraise abstract artistic stimuli to make progress on virtual exploration. At the same time, the Feeling of discovery reflects user intentionality and interest to explore and know about the content in searching for new meanings and hidden symbolism in objects and events (e.g., narrative of the content or flow of virtual environment including story plots or scenes). Then, Creativity has received Encouraging and Degree of attention from Motivation, and Imaginary and Non-narrative from Imaginative construct. The virtual environment should possess an Encouraging, Degree of attention, Imaginary and Non-narrative to induce creativity during virtual exploration.

Next, Creativity merged with Narrative and renamed as Plausible. Non-narrative is merged into Dynamic. Non-narrative describes the state of readiness to perceive multimedia compositions (music, abstract art, architecture, including interaction) through multi-sensorial inputs and outputs) which is presented to the user in a dynamic narrative by implementing a new storytelling approach, genre, fictional, metaphoric, and interaction. The dynamic narrative will support creative and imaginary. Thus, without any doubt, ready to take the opportunity to explore it as it is virtually built. Thus, Plausible has Creative, Encouraging, Degree of attention, Dynamic, Sense of exploration, Imaginary, and Situational context.

Meanwhile, Interactive has received Naturalness from the Intuitiveness construct. Then, zooming and naturalness are merged into action. Zooming is an action that is performed on an interactable object, with the close-up view giving a sense of proximity and distance, which also allows for rescaling the object. At the same time, naturalness is the sense of nature in a virtual environment, and interaction features are composed of replicating natural scenes, events, or phenomena. VR interaction design always tries to accommodate users with natural action. Therefore, those elements share the analogous technicality pertinent to the merging process. As a result, Interactive has four elements; Enjoyment, Feeling of union, Action, and Time. Figure 5 illustrates the formulation process of the initial AIX model named the Triad AIX model.

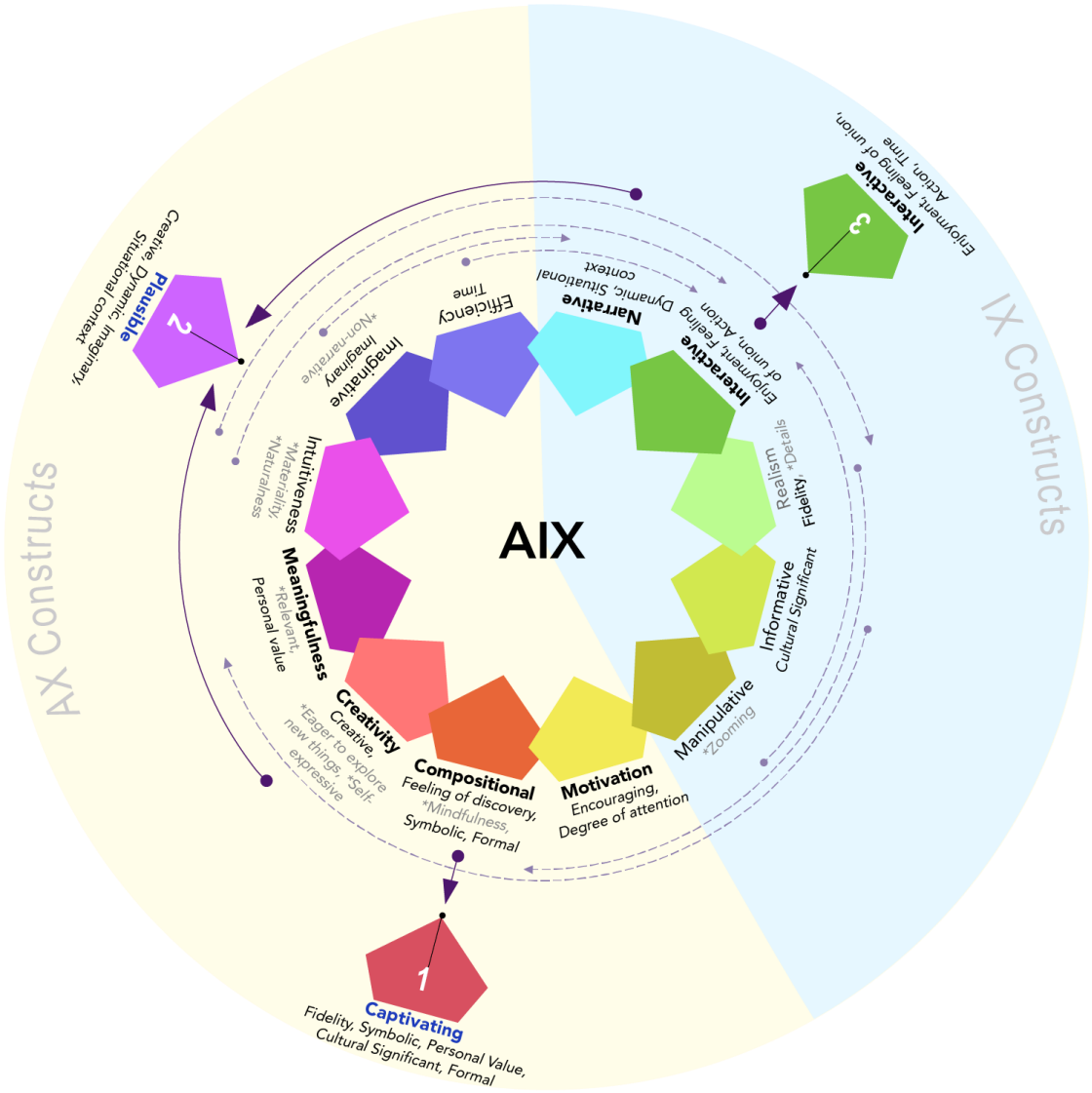

Fig. 5. The formulation process of AIX after FDM

Overall, three (3) constructs and sixteen (16) elements are yielded from formulation namely; 1) Captivating constitutes five elements; Cultural Significant, Fidelity, Symbolic, Personal Value and Formal, 2) Plausible, which consists of seven elements; Creative, Encouraging, Degree of attention, Dynamic, Sense of exploration, Imaginary and Situational context, and 3) Interactive has four elements namely; Enjoyment, Feeling of union, Action, and Time. Figure 6 illustrates the initial AIX model named the Triad AIX model. The initial AIX model was taken in conjunction with diamond shapes (illustrated in the conceptual framework) that represent the three (3) AIX constructs and sixteen (16) elements embedded in it.

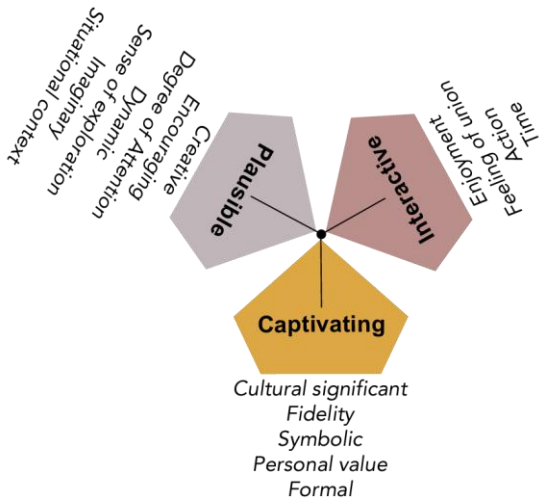

Fig. 6. The initial AIX model

3.5 Discussion

In this study, the AIX model for measuring VR experience was developed based on the consensus among experts. The AX, IX and emotion theories of immersive VR technology mediation were initially analysed and integrated for comprehensive and integrative model development. Although fourteen (14) AX and IX constructs were used, the expert's consensus of FDM indicated that only twelve (12) constructs needed to be included. The FDM process participates in expert consensus at an early stage of model development as it deliberately validates the conception and context of the model.

Fundamentally, the formulation process conducted is to dense the model and enhance the construct's strength and suitability by comprising appropriate elements. However, the process must confer on AX, IX, emotion theory and FDM necessity. Consequently, some existing constructs have been unified, remained, and rebranded due to the addition or retention of the element. Furthermore, certain constructs have remained, and a few have been unified; they have been subject to a renaming or relabelling process in relation to their construct names. Then, all elements in each construct have been ranked according to its fuzzy score.

Furthermore, the contextual meaning or description of the new constructs is refined. In such a case, it becomes the basis and guideline for producing aesthetic products that use immersive HCI devices. The description of each construct and element is as follows:

3.5.1 Captivating

Captivating construct in AIX consists of Cultural Significant, Fidelity, Symbolic, Personal Value and Formal. The AIX product, functioning as VR application, should incorporate fascinating elements by integrating formal, cultural significant and symbolic in 3D virtual environment as motivational mechanism to encourage user further exploring the virtual world. User will have intention and interest to explore and knowing more about the content in searching for new meanings and hidden meaning of cultural significant, formal and symbolic within event or object. Those elements reflect the context of virtual environment which needs to present with an appropriate degree of fidelity. Thus, user will associate with his/her personal value to show inner emotional states and interpersonal relationships for understanding the basic meaning of virtual content.

3.5.2 Plausible

Plausible construct in AIX model consists of Creative, Encouraging, Degree of attention, Dynamic, Sense of exploration, Imaginary and Situational context. AIX products need creative attitude or artistic proposition and imaginary in appraising representation of abstract, multi-modal, dynamic narrative, as well as new situational scene exploration. Imaginary state allows user appraise towards VR scenes to acquire the same feelings as the real world while the feelings are not available in the real world. In this case, it is supported by elements of dynamic and situational context. In order to produce sense of exploration, VR narrative requires new dynamic storytelling approach to produce encouraging content. Encouraging element produce by the visual looks of content and dynamic storyline. Also elevating degree of attention to keep user interest continue exploring the virtual event. Situational context should accentuate the unique qualities of a particular historic site, which help user to get connected to content and immersed.

3.5.3 Interactive

Interactive construct of AIX allows virtual embodiment supports by enjoyment, feeling of union, action and time. Interactive construct allows implementing variety of interactive modes based on different functions and purpose of actions, hence evoking feeling of union and enjoyment. Enjoyment is user's satisfaction when having a chance to make an action upon virtual space and objects. Time is amount of exposure period which user interacts upon the content or else, the effective length of narrative to present the story which producing emotional reaction. Also, in time-space exploration of historical content, user should have sense of time to get immerse in the storyline. This sense allows expressive potential to blends cultural and historical ideas through interactivity within virtual environment.

4. Conclusions

In conclusion, this study has met the research objective, to explain the development of the initial AIX model using FDM. The AIX model was developed using the Fuzzy Delphi Method (FDM). As an inventing tool, the Fuzzy Delphi Method (FDM) uses an analytical method to facilitate the decision-making process by attaining consensus among field experts. It could be used to develop integrated user experience models. Therefore, expert selection is the most crucial stage to take into consideration. Criteria set during the expert selection could affect the model development.

The formulation requires the researcher to understand the theories studied intensely during the literature review. A methodological review should implement a narrative and systematic approach to obtain detailed and structured knowledge of the research subject. Reviewing the literature involves researching, reading, analysing, evaluating, and summarizing scholarly literature. The method enables the researcher to appropriately unify and eliminate constructs, components, or elements during the formulation process in order to construct a comprehensive model.

The initial AIX model could be a subject of user experience evaluation related to any immersive product. However, its practicality has to be proven by real application and implementation in the field. A prototype of a VR historical event or VRHE application should be built to validate the model in an actual situation to gain empirical applicability proof of the model. Therefore, the following study will validate the initial AIX model using the VRHE application as a stimulus. The initial AIX comprised construct and elements become the basis for developing measurement items of the AIX questionnaire together with the VRHE application. Data collection will be conducted through an AIX

questionnaire on users who have used the VRHE application. Then, the data from the questionnaire will be analysed using Confirmatory Factor Analysis (CFA) of the Structural Equation Modelling (SEM). The validation process empirically confirms the final vital constructs and elements that are reliable for immersive technology-based applications or products. Implementing those tools will affirm the constructs and elements as central subjects of conducting the research. Eventually, the initial Aesthetic Immersive Experience (AIX) model should be recommended for VR historical event development.

The main contributions of this study are in the field of art and human-computer interaction. Firstly, the AIX model integrated the AX and IX to develop a virtually aesthetic immersive experience among users. Thus, filling the gap in this area of knowledge. This model emphasises immersive virtual mediated experience through investigating, explaining, and concluding AX and IX theories. The results of this study are significant for VR researchers, developers, and museum professionals in the HCI field and heritage industry. The AIX model could be used during immersive and media art product development for the immersive industry and history education. The developers require standard guidelines for developing a quality VRHE application that meets user requirements. Thus, key industry players must have integrative models to create a supportive VR environment to improve the museum experience among visitors.

This study examines VR historical events stimuli as a research subject applicable to numerous creative extended-reality (XR) or immersive technologies products for future investigation. The proposed products include virtual reality (VR) games, augmented reality (AR) games, or both. This study focuses primarily on 3D modelling and animation as an art form, while numerous other art forms could serve as research subjects to yield diverse outcomes. The animated content in this study is three-dimensional. Thus, future research could explore alternative art forms and recommend producing stylized animated content, incorporating special effects or motion graphics generated from artificial intelligence (AI) applications. Moreover, the AIX model is expected to facilitate the expansion of the Malaysian immersive heritage sector by promoting the creation of extended-reality (XR) historical events while maintaining the integrity of historical events and museum exhibition methodologies that have traditionally defined them.

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