Virtual Reality at a Prehistoric Museum: Exploring the Influence of System Quality and Personality on User Intentions

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Virtual Reality (VR) promises many benefits for the tourism industry. However, a review of tourism-related VR research shows that the roles of system quality and user personality remain largely unexplored. This study examines the causal relation underlying VR quality (information quality, interactivity, and visual attractiveness) and the user's personality (openness to experience, conscientiousness, and social influence) in conjunction with usability, attitude, and behavioural intention. We collected user data from a VR tourism experience of the Sangiran museum at Surakarta, Indonesia using a Head Mounted Device VR. The Sangiran museum is an archaeological excavation site recognised as a world heritage site by UNESCO. Two hundred eighteen valid responses were analysed using Structural Equation Modelling. The result suggests that only visual attractiveness positively impacts usability from a VR quality perspective, while openness to experience and social influence show significant positive evidence of attitude. These findings are discussed based on the practical and theoretical implications, including future research opportunities into VR tourism.

CCS Concepts: • **Human-centered computing** → **Empirical studies in HCI**; **User studies**; **Virtual reality**;

Additional Key Words and Phrases: Head-mounted devices, personality, system quality, tourism, Virtual Reality

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1 INTRODUCTION

Virtual Reality (VR) is an interactive three-dimensional environment simulation generated by computer technology [1]. It allows the users to explore the effect of active imagination by creating a sense of presence in an artificial environment [2, 3]. VR is an important technology that significantly impacts the tourism industry. It offers virtual tours of tourism attractions or landmark experiences using various kinds of VR viewers from a low cost such as Google Cardboard, or a high-end **Head Mounted Device (HMD)** like HTC Vive Cosmos. VR has a unique ability to simulate a real-life environment [4] that brings many benefits to tourism [5]. Tourism is well known as one of the largest industries in the world [6], however, it dropped dramatically due to the global pandemic (Covid-19) during 2020 [7]. The use of VR in tourism can be beneficial not only as effective marketing [8–10] but also as a substitute to actual trips [11, 12] where there is a travel restriction (e.g., due to global pandemic) [13].

One potential benefit of VR in tourism is tourism promotion media [14] that help the potential tourist to get a better-informed decision in a more realistic experience [11, 15]. Several existing studies focus on observing VR usage in tourism and its influence on user behaviour intention. For example, the user's intention to visit a tourism destination will increase by the influence of the user's sense of presence in the virtual environment [16–18], enjoyment during VR experience [19], absorptive experience [20], and authentic experience [21]. A study by Wei et al. [18] concluded that the participant who has experienced a VR roller coaster at the theme park also found that a sense of presence leads to a greater user's intention to recommend and revisit the tourism destination. Additionally, experiencing VR influences the user to use VR again in the future [22]. While prior studies have made contributions to VR in tourism, this study identified research gaps. There is a need to study how VR quality and users' personalities may influence users' behavioural intentions. Our study is in line with the suggestion from previous studies to explore the influence of personality [21, 23, 24] and the technology-related variables [23] on VR tourism usage. We believe that both system quality and the user's personality play a role in influencing potential visitors to visit the tourism destination and use VR as a decision tool.

In light of the gaps as mentioned earlier in knowledge, this study aims to examine the effect of VR in tourism from a system quality perspective (information quality, interactivity, visual attractiveness) and the user's personality perspective (openness to experience, conscientiousness, social influence) toward the user's behavioural intention. We designed a research model to show the relationship between constructs and conducted hypothesis testing using **Structural Equation Modeling (SEM)**. The findings from this study contribute to a better understanding of how VR usage might affect tourist behaviour intention. The study will also benefit the tourism destination provider and VR developer to design a more focused VR content to represent the promoted tourism destination.

2 THEORETICAL FOUNDATION

This research aims to understand better the behavioural intention of using VR tourism by proposing and testing a research model of the determinants of tourists' attitudes and behavioural intentions. The **Theory of Reasoned Action (TRA)** [25] provides a foundational structure for this model through the underlying principle linking people's intentions and their behaviour. In TRA, it is stressed that attitude is a determinant of behavioural intention, and this is represented in our research model. We develop a new research model by extending this basic structure in two key dimensions: system quality and user personality. We provide further theoretical development for each of our hypothesized relationships in the following sections.

Usability was the most gained interest to investigate within the user experience component, aside from technology adoption [26]. Usability is commonly described as the system's ability to provide the condition for the user to perform a task with effectiveness, efficiency, and satisfaction to achieve a specific goal [27]. Jordan [28] stated that usability is the attribute of a user's interaction with a system with a specified task, that is that it may be context dependent. Similarly, Brooke [29] stated that measuring effectiveness, efficiency, and satisfaction can

vary depending on the task and defined usability as the quality of appropriateness of a system to meet its purpose. Therefore, for our specialised research area in VR, it was necessary to contextualise the construct of usability. We also posit that several dimensions of VR system quality will influence the perceived usability of the environment.

Building on prior research, we believe that the success of VR as a tourism promotion tool will be influenced by several dimensions of system quality: information quality, interactivity, and visual attractiveness, all of which may influence the system usability. Finally, we suggest that users' personality traits, notably their openness to experience, conscientiousness, and social influence may shape their attitude toward using VR. The proposed model thus incorporates these three dimensions of users' personality.

Information quality refers to the degree of completeness and ease of understanding the provided information [30–32]. In most of the previous studies, information quality was found to influence ease of use [33–35], usefulness [34–38], and satisfaction [39, 40].

We defined interactivity as the interaction between virtual reality and users. Interactivity is the bidirectional flow of information between the user and the VR system. Johnson et al. [41] identified interactivity as a reflection of reciprocity, responsiveness, speed of response, and nonverbal information of the system. Gu et al. [42] found that the relationship between interactivity and usefulness was positively significant on the influence of mobile internet-based health service usage on word-of-mouth dissemination behaviour. Lowry et al. [94] found that interactivity directly predicted satisfaction in the context of website usage.

In this study, visual attractiveness refers to a degree where the user senses the system aesthetically pleasing to the user's eyes [43]. Previous researchers confirmed that visual attractiveness would directly influence ease of use and usefulness [44, 45]. Therefore, we expect that the visual attractiveness of the VR system would enhance usability.

Despite the lack of clarity around the specific relationship between system quality and usability, we proposed that the various dimensions of system quality all positively influence usability. Therefore, we hypothesize that:

H1a: Information quality positively influences usability.
H1b: Interactivity positively influences usability.
H1c: Visual attractiveness positively influences usability.

Attitude refers to a person's overall feeling of favourableness or unfavourableness toward an object's stimulus [25]. Several theories have suggested that the users (positive) experience with a system will influence their attitude and thus lead to a desired behavioural outcome. For example, TAM [46] considers that usefulness and ease of use affect the user's attitude toward technology, leading to behavioural intention. A usable system meets the user's requirements and reduces the cognitive effort related to system usage. There is a direct effect of usability on attitude in website design studies [47, 48]. Thus, there should be a link between usability and attitude toward using the VR system. Therefore, we hypothesize that:

H2: Usability positively influences attitude.

The Big Five model provides a well understood model that reflects personality traits in five dimensions, including openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism [49]. Based on prior work, two of these dimensions, conscientiousness and openness to experience, are potentially relevant in this study area. Openness to experience indicates a degree of being curious and broad-minded. A person who is open to experience tends to try new things [49]. People who score low on openness to experience tend to be conventional in their behaviour. Although previous studies related to promotional technology [50, 51] found no significance on the relationship between openness to experience and attitude, we believe that openness to experience affects attitude since VR is a state-of-the-art technology that gives a new experience. Conscientiousness refers to the degree of being thoughtful, organized, and planful [52]. A high score on conscientiousness indicates a person who is disciplined and works according to a plan to achieve his/her goal. There is a previous

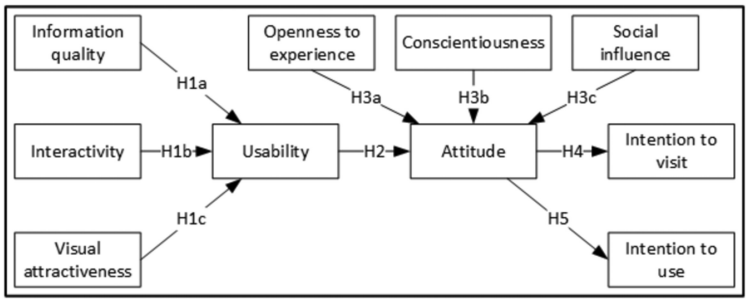

Fig. 1. Research model.

mixed finding found on the correlation between conscientiousness and attitude. Zhang et al. [53] stated that there was significant positive evidence that conscientiousness directly affects the attitude in the smartphone recycling context. In contrast, Chua and Chua [54] found a negative effect of conscientiousness on the attitude toward Facebook.

Finally, social influence refers to a person's attitude and opinion as part of decision-making as a result of influence from referents they interact with [55]. Social influence affects attitude and is represented as subjective norm on TRA [25], and **Theory of Planned Behaviour (TPB)** [56]. Numerous studies [57–62] found a significant effect of social influence toward attitude, for instance, in the context of electronic government system adoption [58], mobile payment adoption [59], and customer purchase intention via mobile app technology [62].

We propose that these aspects of personality positively influence the attitude of using VR. Therefore, we hypothesize that:

H3a: Openness to experience positively influences attitude.
H3b: Conscientiousness positively influences attitude.
H3c: Social influence positively influences attitude.

In TPB [56], attitude is one of key component that leads to behavioural intention. The relationship of attitude toward technology and behavioural intention is positively significant in many studies involving information systems [44, 63–67]. Taking consideration of the consistent results from previous studies, we hypothesize that:

H4: Attitude positively influences intention to visit a tourism destination.
H5: Attitude positively influences intention to use VR as a recommendation tool.

Integrating the mentioned literature and hypotheses, we propose a research model for understanding how VR usage in tourism influences toward behavioural intention (see Figure 1).

3 METHOD

3.1 VR Application Design and Features

The virtual environment (see Figure 2) represents part of the Sangiran museum, a prehistorical museum in Surakarta, Indonesia. The immersive technology lab of Sebelas Maret University developed the VR application. The VR was built by artificially generated three-dimensional objects using Unity software to resemble the actual exhibit. The application was intended to give information about the exhibit and its displayed objects.

During data collection, the participants used a BoboVR headset and a joystick to experience the virtual environment (see Figure 3). A smartphone was used to run the VR application and was placed inside the VR headset with built-in headphones. Participants can see the surrounding virtual environment with natural head movement (i.e., vertically, horizontally).

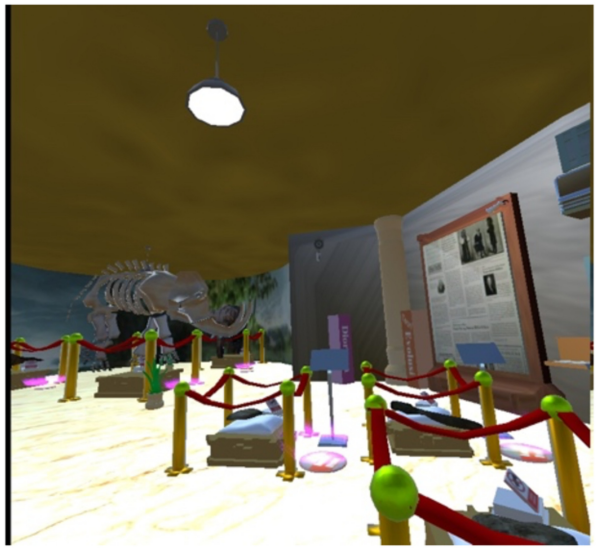

Fig. 2. Sangiran museum VR application.

Fig. 3. Participant experience VR during expo event.

3.2 Experiment Design

During the VR experience, the participants explore the virtual environment from the first-person point of view without any avatar. There are no non-playable characters within the VR environment. Participants' movement in the virtual environment was controlled by a joystick, including choosing any particular object they were interested in with the joystick's button. As the users near to an object, they can access the information about that specific object. Some information was available as textual or in voice narrative form that can be heard from the headphone.

Table 1. Construct's Definition and Measurement Items

Construct	Definition	Measurement items
Information quality	How the provided information in VR meets the user's needs in terms of being understandable and adequate.	[68]
Interactivity	The user's interaction within the VR environment. It covers the action-response between input from the user and output from the system in real-time simulation.	[69]
Visual attractiveness	How pleasant the visual element presented by VR is through the user's visual perception.	[44]
Usability	The degree of ease of use and effectiveness of use where specified users can use VR to effectively complete specific tasks, with efficiency, and satisfaction.	[29]
Openness to experience	The degree of being imaginative, cultured, curious, original, broad-minded, and intelligent [52].	[70]
Conscientiousness	The degree of being thoughtful, organized, and planful [52].	[70]
Social influence	The influence of people whom someone interacts with that stimulates attitude and opinion.	[71]
Attitude	A person's general feeling of favourableness and unfavourableness toward VR.	[72]
Intention to visit	The user's intention to visit a tourism destination after experiencing VR tourism.	[21]
Intention to use	The user's intention to use VR technology as part of tourism destination recommendation in future travelling.	[44]

3.3 Experiment Setup

This study applies a quantitative research design using a survey questionnaire for data collection. We collected the data in September 2019 (prior to the Covid-19 global pandemic) during an expo in Surakarta, Indonesia. All participants were located in Indonesia and aged 18 or over. We conducted data collection by following a protocol. First, we approached random visitors at a prepared booth and asked if they were willing to participate in the study. Then, we explained the project to each participant. Next, we mentioned the task that the participants needed to do during the VR experience. Later, we followed up by asking about their concerns. We then asked the participants to experience the VR for five minutes. Finally, we asked the participants to complete a questionnaire about the VR they just have experienced.

3.4 Measures

The constructs measured were information quality, interactivity, visual attractiveness, openness to experience, conscientiousness, social influence, usability, attitude, intention to visit, and intention to use. Measurement items were adopted from previous studies (see Table 1) and slightly reworded to adjust with the context of the study. Some items include reversed statements to indicate the participants' engagement toward the questionnaire. Table 2 provides a list of all the measurement items and their references. The items measured using 5-point Likert scales from 1 "Strongly Disagree" to 5 "Strongly Agree". The questionnaire included a set of questions aimed at the demographic profile of participants. As this study was conducted in Indonesia, the questionnaire was translated into Bahasa Indonesia by a member of the research team who is a native speaker to ensure that the measurement items have a similar meaning to the original language. The initial questionnaire was pilot tested with several expert people, and some minor changes were undertaken based on the feedback to improve the questionnaire.

Table 2. Construct's Measurement Items

Construct	Cronbach's Alpha	Code	Items	Factor loading
Information Quality (Adapted from [68])	0.899	IQ1	It is easy to interpret what the information means.	0.86
		IQ2	This information is easy to understand.	0.85
		IQ3	The meaning of the information is difficult to understand. (R)	0.82
Interactivity (Adapted from [69])	0.809	IN1	While using the Virtual Reality, my actions decided the kind of experiences I got.	0.62
		IN2	The Virtual Reality processed my action very quickly.	0.65
		IN3	I was able to obtain the information I wanted without any delay.	0.85
		IN4	When I clicked on the objects, I felt I was getting instantaneous information.	0.81
Visual Attractiveness (Adapted from [44])	0.838	VA1	The tourism destination as seen through the Virtual Reality application is visually appealing.	0.82
		VA2	I felt the tourism destination as seen through the Virtual Reality application shows attention to design detail.	0.90
		VA3	The tourism destination environment as seen through the Virtual Reality application provided a way for users to easily experience it.	0.69
Openness to Experience [70]	0.878		I see myself as someone who …	
		OE1	… is inventive.	0.75
		OE2	… is original, always comes up with new ideas.	0.78
		OE3	… values artistic and aesthetic experiences.	0.71
		OE4	… has an active imagination.	0.71
		OE5	… likes to reflect and play with ideas.	0.70
		OE6	… is sophisticated in art, music, or literature.	0.67
		OE7	… is ingenious and a deep thinker.	0.77
		OE8	… is curious about many different things.	0.65
Conscientiousness [70]	0.816		I see myself as someone who …	
		CO1	… works in detail.	0.75
		CO2	… does things efficiently.	0.76
		CO3	… makes plans and follows through with them.	0.71
		CO4	… is a reliable worker.	0.72
		CO5	… keeps working until the task is finished.	0.76
Social Influence (Adapted from [71])	0.987		I would like to experience Virtual Reality that…	
		SI1	… I have heard about from family/friends/co-workers.	0.95
		SI2	… is popular among my family/friends/co-workers.	0.99
		SI3	… has been recommended by family/friends/co-workers.	0.98
Usability (Adapted from [29])	0.751	US1	I found the Virtual Reality unnecessarily complex. (R)	0.80
		US2	I think that I would need the support of a technical person to be able to use this Virtual Reality. (R)	0.75
		US3	I thought there was too much inconsistency in this Virtual Reality. (R)	0.68
		US4	I found the Virtual Reality is very cumbersome to use. (R)	0.72
Attitude (Adapted from [72])	0.813	AT1	Using the Virtual Reality is a good idea.	0.65
		AT2	Using Virtual Reality is a foolish idea. (R)	0.87
		AT3	I like the idea of using the Virtual Reality.	0.79
		AT4	Using the Virtual Reality is unpleasant. (R)	0.83

(Continued)

Table 2. Continued

Construct	Cronbach's Alpha	Code	Items	Factor loading
Intention to Visit (Adapted from [21])	0.934	IV1	I am planning to visit the place that I observed in the tourism-related Virtual Reality activity.	0.80
		IV2	I intend to visit the place that I saw in the tourism-related Virtual Reality activity in near future.	0.84
		IV3	I am willing to visit the place that I saw in the tourism-related Virtual Reality activity soon.	0.85
		IV4	I intend to invest money and time to visit the place that I observed in the Virtual Reality tourism.	0.84
Intention to Use (Adapted from [44])	0.984	IU1	I intend to use the Virtual Reality for getting information about tourism destination in the future.	0.75
		IU2	I predict I would use the Virtual Reality for getting information about tourism destination in the future.	0.74
		IU3	I plan to use the Virtual Reality for getting information about tourism destination in the future.	0.74

Note: (R) indicates reversed items.

3.5 Data Screening

We began the data analysis phase with data screening by identifying missing data and any not-fully engaged participants to improve data quality. First, we eliminate any record with missing values of more than 10% to avoid statistical analysis bias [73]. Second, we also eliminate any record with a standard deviation of less than 0.50 as it indicates unengaged responses [74]. This yielded a usable sample of 218 valid responses.

4 ANALYSIS AND RESULTS

There were 64.7% male and 35.3% female responses. The majority of the participants were between the ages of 18-25 (78%). One hundred thirty-eight participants (36.7%) had previous experience with VR in the past. This is summarized in Table 3. Data normality can be confirmed with all variables' skewness value outside the ±2 range [75] and no kurtosis value considered as problematic (>10 [76]). This study utilized the SEM approach to test the proposed research model (see Figure 1). SEM is a statistical methodology that takes the hypothesis-testing approach to test a causal process based on prior theory [76, 77]. The model represents theory as related constructs measured with observed construct items [78]. In applying SEM, the relationship between latent variables and their measures are estimated for validity and reliability before analysing the structural model to test the latent variables' relationship [79]. Therefore, we utilized **Exploratory Factor Analysis (EFA)** and **Confirmatory Factor Analysis (CFA)** prior hypotheses testing using the structural model. We analysed the data using IBM SPSS Statistics version 26 for performing EFA. We chose covariance-based SEM by utilizing IBM SPSS Amos version 26 for performing both CFA and structural model analysis for hypothesis testing.

The mean level of the constructs is above neutral. Nine constructs had an average between 3 and 4, while attitude has a mean value of more than 4. This suggests that respondents generally had a positive attitude toward using VR (4.2/5). Moreover, usability is slightly above neutral (3.3/5), suggesting that respondents believe that the VR meets some usability elements. These findings are summarized in Table 4.

4.1 Exploratory Factor Analysis

We conducted EFA with Principal Component Analysis extraction and the Promax rotation method. The analysis indicated ten factors (see Table 2) after excluding items that did not load sufficiently. The **Kaiser-Meyer-Olkin (KMO)** and Bartlett's test for sampling adequacy indicated as significant with a value more than 0.50 (KMO = 0.80, p = 0.000) indicates the data is proper for further analysis [79]. Another indication of sample adequacy is the

Table 3. Background Profile of Participants

Characteristic	Frequency $n = 218$	%
Gender		
Male	141	64.7
Female	77	35.3
Age		
18–25	170	78.0
26–35	32	14.7
36–45	12	5.5
46–55	3	1.4
56–64	0	0.0
65 or older	1	0.5
Occupation		
Employed	72	33.0
Unemployed	22	10.1
Retired	1	0.5
Student	121	55.5
Housewife/husband	2	0.9
Highest Education		
Primary school	8	3.7
Secondary school	46	21.1
Vocational school	100	45.9
Bachelor's degree	57	26.1
Postgraduate degree	6	2.8
Doctoral degree	1	0.5
Previous experience with VR		
Yes	138	63.3
No	80	36.7

Table 4. Descriptive Statistics

Construct	Minimum	Maximum	Mean	SD	CR
Information quality	1.00	5.00	3.93	0.50	0.90
Interactivity	1.00	5.00	3.75	0.52	0.81
Visual attractiveness	1.00	5.00	3.87	0.54	0.84
Openness to experience	2.00	5.00	3.73	0.53	0.88
Conscientiousness	2.00	5.00	3.84	0.47	0.82
Social influence	2.00	5.00	3.76	0.66	0.99
Usability	1.00	5.00	3.30	0.71	0.75
Attitude	2.75	5.00	4.22	0.57	0.81
Intention to visit	1.50	5.00	3.50	0.73	0.93
Intention to use	2.00	5.00	3.72	0.70	0.98

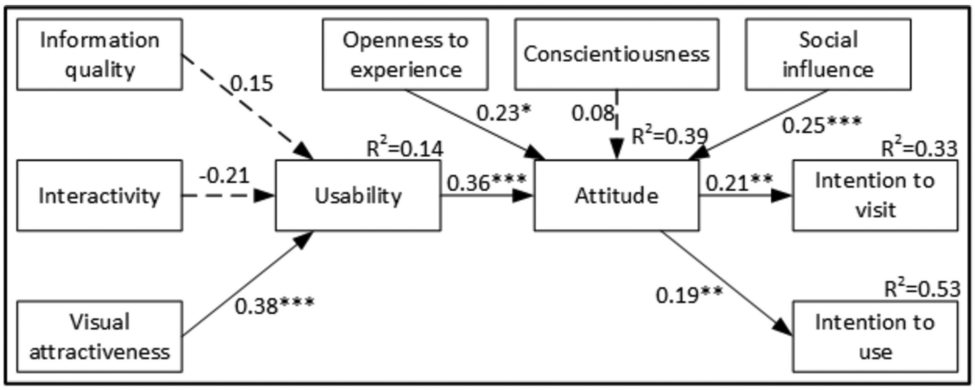

Fig. 4. Structural model result. *p < .05, **p < .01, ***p < .001.

extracted communalities where all the items' communalities were above 0.50 [79]. Ten factors were recognized during this stage, with eigenvalues >1 and 72.5% of the total variance. The factors also proved both convergent and discriminant validity where no strong cross-loading between items (>0.3) and the average factor loadings were more than 0.70 in the pattern matrix [79]. Reliability is the last validation criterion for an EFA. Cronbach's Alpha value for each factor (see Table 2) was more than the minimum value of 0.70, indicating good reliability [79].

Before evaluating the model, we conducted two **Common Method Bias (CMB)** tests to examine if method bias was a potential concern for inflating or deflating the relationships between observed variables. All measurement items from the respondent were collected simultaneously, indicating potential sources of common method bias [80]. We identified CMB using two methods. First, the obtained result of Harman's one-factor test was 24.92%. The value was below 50%, which suggests that the data was not affected by CMB. Second, we calculated the **Variable Inflation Factor (VIF)** to detect method bias. All VIF values are less than the threshold (<3.3 [81]), which indicated that the model was free of method bias.

4.2 Confirmatory Factor Analysis

Next, we performed CFA to confirm the extracted factor structure in the EFA. To ensure the quality criteria for validity and reliability, one item was dropped since its value was below 0.50 [79]. Convergent validity was assessed using **Average Variance Extracted (AVE)** and the **Composite Reliability (CR)** values, while discriminant validity used the Fornell-Larcker criterion [82] and **Heterotrait-Monotrait (HTMT)** ratio [83]. Table 5 lists the analysis results. The AVE should be more than 0.50 with CR greater than 0.70 to meet convergent validity [79]. This study applied plugins for AMOS [84] to calculate those values. Although two factors have AVE slightly below 0.50, the convergent validity can be considered adequate based on CR alone since AVE is stricter than CR [85]. Discriminant validity was established by assessing the Fornell-Larcker criterion, where each construct's AVE's square root was greater than its correlations with other constructs.

Moreover, the HTMT analysis supports discriminant validity. The shared HTMT value was above the recommended threshold of 0.90 [83]. Finally, the results show that the CFA model's ten factors have a goodness of fit ($\chi 2$/df = 1.91, CFI = 0.91, SRMR = 0.05, RMSEA = 0.07) within acceptable criteria [79].

4.3 Structural Model and Hypothesis Testing

After CFA completion, we specified and examined the causal model. The structural model results are illustrated in Figure 4, including the path coefficients and its significance. The fit indices of the structural model ($\chi 2$/df = 1.93, CFI = 0.90, SRMR = 0.07, RMSEA = 0.06) indicate a good model [79]. H1a and H1b were not supported

Table 5. Fornell-Larcker Criterion and Heterotrait-Monotrait Ratio (HTMT)

	CR	AVE	Fornell-Larcker criterion										HTMT									
			IV	OE	CO	SI	IQ	AT	VA	US	IN	IU	IV	OE	CO	SI	IQ	AT	VA	US	IN	IU
IV	0.935	0.782	0.885																			
OE	0.850	0.533	0.315	0.730									0.310									
CO	0.794	0.492	0.126	0.570	0.701								0.125	0.579								
SI	0.987	0.963	0.538	0.449	0.255	0.981							0.543	0.433	0.257							
IQ	0.911	0.775	0.130	0.257	0.326	0.122	0.880						0.125	0.257	0.333	0.134						
AT	0.820	0.538	0.419	0.377	0.329	0.450	0.198	0.733					0.409	0.352	0.316	0.439	0.198					
VA	0.841	0.639	0.405	0.343	0.223	0.350	0.575	0.368	0.800				0.398	0.323	0.210	0.341	0.577	0.366				
US	0.773	0.535	0.182	0.054	0.138	0.248	0.215	0.432	0.333	0.731			0.183	0.065	0.146	0.248	0.227	0.468	0.330			
IN	0.773	0.532	0.041	0.253	0.302	0.153	0.683	0.184	0.545	0.107	0.729		0.027	0.250	0.295	0.143	0.677	0.115	0.536	0.076		
IU	0.985	0.956	0.707	0.376	0.210	0.511	0.252	0.434	0.465	0.317	0.197	0.978	0.713	0.371	0.214	0.516	0.268	0.432	0.470	0.337	0.197	

since information quality was positively associated with usability but not significant ($\beta = 0.15$, $p > 0.05$), while the direct effect between interactivity and usability was inversely related and not significant ($\beta = -0.21$, $p > 0.05$). The relationship between visual attractiveness and usability was positive and statistically significant ($\beta = 0.38$, $p < 0.001$), supporting H1c. The results showed that its predictors accounted for 14% of the variation in usability.

Further analysis shows that usability positively influences user's attitudes giving support H2 ($\beta = 0.36$, $p < 0.001$). Additionally, 39% of the variation in attitude was explained by its predictors. As predicted by H3a and H3c, both openness to experience ($\beta = 0.23$, $p < 0.05$) and social influence ($\beta = 0.25$, $p < 0.001$) have a significant positive effect on attitude. However, H3b was not supported indicating that conscientiousness was not significantly correlated to the attitude using the VR significant ($\beta = 0.08$, $p > 0.05$). The direct effect of the paths from attitude to both intention to visit ($\beta = 0.21$, $p < 0.01$) and intention to use ($\beta = 0.36$, $p < 0.01$) were positive and significant, supporting H4 and H5, respectively. Finally, 33% of the variation is intention to visit. At the same time, 53% of the variation in the intention to use were accounted for by its predictor.

5 DISCUSSION

The current study found that only visual attractiveness (from the system quality perspective) affects usability. Another important finding was that both openness to experience and social influence are two factors from the user's personality that influence the user's attitude toward using VR. The results also support the claim that the user's attitude toward VR impacts their behavioural intention. This study reveals that 7 (out of 10) hypotheses were supported. Further, the findings cannot be generalised to the entire population. More than 75% of the participants fell in the 18–25 years of age group. Therefore, people in this group might be considered technology-savvy, whereas the older generation might not. In addition, people in the 18–25 age range might be considered the right target audience for using VR in tourism.

This study argues that the system quality (information quality, interactivity, and visual attractiveness) influences usability. Usability covers usefulness, ease of use, and satisfaction [86]. We found that visual attractiveness has a strong and positive influence on usability. The result is in line with those of previous studies on virtual worlds [87], AR [88], and learning management systems [45]. If the user feels the VR has sufficient visual aesthetic this can ultimately influence VR usage. This supports the prior finding that visual attractiveness is one crucial factor in enhancing the overall tourism experience [89, 90]. In addition, Dehghani et al. [91] stated that their study participants indicated visual appearance as one of the main concerns using VR. Modern VR technology uses 360° panorama images or video to represent the actual destination as realistically as possible compared to a computer-generated virtual environment.

This study found that the other two dimensions of system quality were not significant determinants of usability. First, information quality did show a positive effect on usability, although it is not statistically significant. The result suggested that information quality was not statistically related to usability. This unexpected result is in contrast with a prior study by Shatnawi and Algharabat [92], where they found that information quality has positive influence toward usability in website usage context. Further, the authors stated that information quality was the most significant factor predicting usability. A viable explanation of the insignificant relationship between information quality and usability in this study could be either the volume of or the way that the information is presented. Typically, websites contain rich information, primarily textual in nature. VR, on the other hand, emphasizes viewing the virtual environment rather than finding specific information. Users might have preferences for either sound, visual or textual media when performing information seeking tasks, and in website studies may associate these factors with information quality. On the other hand, in the VR environment, the users have a more consistent experience, which is heavily geared toward the visual imagery. As such, these dimensions of information quality may not be directly comparable with prior studies. Furthermore, the mean levels of information quality in our study were high (3.93/5) raising the possibility that this generally high construct value may have attenuated the correlations examined in our model testing [93]. These findings

highlight the need for future work to be contextualised in the VR environment, and for future studies to consider a wider range of experimental materials to better understand the role of user perceptions. The purpose of VR usage should also be considered. VR as a promotion tool might focus on answering users' expectations like why they need to visit the destination, how to get there, or when is the right time to visit the destination. It might be different for VR as a learning tool or part of actual visitation that might focus on each specific virtual object. Whether the information is being presented in textual, visual, or sound media, the information delivery must be straightforward and sufficient to the user need.

Second, we also did not find the hypothesized relationship between interactivity within the virtual environment and usability. This contradicted previous studies on website [94] and mobile internet-based health service [42] usage. Once again, a possible explanation for the result is found in the differing levels of interactivity found in the various studies. Websites are typically low in interactivity as compared to a VR experience. Therefore, if this study had a wider range of materials, including some fewer interactive ones (i.e., simple website), then a fuller comparison could have been made. It is also possible that since users are accustomed to low interactivity (and were primed for this as they accessed the experimental materials via the web), that they could have felt overloaded, and their experience was not positively influenced by this extra information. This is a promising area for continued research as it raises the question whether it is possible for a system to have *too much* realism and interactivity. Results might also be different if the user goals were directly aligned with interactivity – for instance if they were using VR as a learning tool, or as a replacement for physical travel. The more users engage in an activity; the more immersed the users interact with the virtual environment by avoiding unnecessary information [95].

We found significant positive evidence from the relationship between openness to experience or social influence toward attitude from the user's personality perspective. Interestingly, there is a significant positive correlation between openness to experience and attitude found in this study compared with previous studies' results [50, 51]. This study's result is as expected since an individual who tends to score high on openness to experience is likely to be more open-minded and willing to try new things. Several studies [57–62, 96] also support the significant positive correlation between social influence and attitude toward using VR. This study's possible explanation is that since this study took place in Indonesia, which has a high level of collectivistic culture, indicating a characteristic where individuals integrate into a solid and cohesive group to possess a strong group bond consciousness [97].

On the other hand, this study has been unable to demonstrate a significant relationship between conscientiousness and attitude despite the positive direction of the correlation. This might be that highly conscientious individuals have the same general attitudes toward using VR as the rest of the study population. Though, we had anticipated that individuals with a high score on conscientiousness may tend to plan their tourism trips as they are more organized in achieving goals [98]. The result is in contrast with a study [53] where they found a statistically significant positive relationship between conscientiousness and attitude in smartphone recycling intention context. A significant negative result was in a study [54] in social networking sites usage. However, it is understandable since individuals with high conscientiousness scores tend to avoid using social media to avoid distraction. The mixed findings from prior work once again highlight that both studies and findings are to be contextualised to a specific environment and may not be easily generalisable to a new interaction medium such as VR. Our study therefore sets the scene for further investigations and ongoing research to fully understand the implications of this growing area of technology.

The present study also confirms a significant causal relationship between usability and attitude. The positive relationship is consistent with previous studies' findings [48, 99]. This study also attempted to assume that the users' attitude toward VR tourism influences their intention to use VR and intention to visit tourism destinations. Our findings agree with prior studies that found statistically positive significant evidence between user's attitude toward intention to use [44, 63–67] and intention to visit [44].

5.1 Theoretical Implications

This study provides a comprehensive insight into understanding the influences of social and usability dimensions when using VR as a tool for tourism trip decision-making. We highlight how factors from system quality and user's personality perspective impact the potential visitor's behavioural intention. To our knowledge, there is a lack of empirical studies which include personality traits on VR for tourism promotion. Our results also highlight that finding cannot be easily generalised from prior work, and that direct study in the area of VR is necessary. This study's initial assumptions support the idea that users' personalities influence the attitude toward using VR, leading to their intention to use VR and visit the tourism destination. Additionally, we contributed to understanding users' behavioural intention from three aspects of quality: information quality, interactivity, and visual attractiveness. Visual attractiveness is a strong effect determinant for the success of VR usage. Visual presentation in VR content must reflect the tourism destination's real-world conditions to accommodate information to support actual visitation decisions.

5.2 Practical Implications

There are few possibilities of how the findings can be manifested in using VR for tourism areas. One significant finding from this study is visual attractiveness. The relevance of this dimension is even observed in direct reports from VR users. For example, the National Geographic Explore VR app designed for Oculus HMD is produced by a well-known organisation and targets a high-end VR platform. When reviewing user feedback and rankings [100], it can commonly be seen that visual attractiveness has been identified as the exciting aspect of the app by end-users. Similarly, although our study did not yield a significant link between interactivity and behavioural intention, user reviews also commonly note that the VR app was interactive enough for their needs. This suggests a direct practical application of our findings as we study aspects which are understood and sought out by end-users. Ultimately, interactivity within the VR content might be preferable rather than no interactivity at all.

In this age of travel restrictions, virtual and online experiences have also grown exponentially. A platform such as The Conqueror [101] offers users a range of journey challenges (e.g., trip to Mount Fuji, Mount Kilimanjaro, Grand Canyon) while at the same time experiencing virtual experiences of key milestones on the trip. Applications of this nature might attract funding from tourism providers if they directly promote the destination by advancing the virtual experience (i.e., cultural heritage site). Interestingly, the above-mentioned platform leverages other dimensions found in our model for its success. For example, The Conqueror leverages the social influence dimension by enabling the user to team up with the others to complete the challenge. There is excellent potential for this kind of application to flourish and further develop if they can develop the social network within the application to allow finding travelling partners worldwide to complete the challenge. As the number of users grows, it gives an ample opportunity to improve the VR aspects of the application to promote tourism.

6 LIMITATIONS AND FUTURE RESEARCH

There are some limitations of this study that should be noted. First, the participants' geographical location is from Indonesia and specific to one tourism destination (i.e., Sangiran museum). The results cannot be generalized to represent the entire population or other tourism destinations. Future research should thus implement the research model on populations from different geographical locations, cultures, and tourism destinations. Second, this study was conducted before the global pandemic (Covid-19). In many countries, the travel restrictions policy might change the way people trip for tourism purposes and see VR as an alternative to experience tourism travel without leaving home. Future studies of VR in tourism should compare how people use VR for tourism before and after the global pandemic.

Furthermore, the future study might examine VR as a tool for tourism travel replacement. Third, the virtual environment of VR for tourism promotion should represent the actual condition of the tourism destination. Therefore, future studies might include comparing computer-generated content and 360° technology and their influence on visiting the tourism destination.

7 CONCLUSION

To sum up, this study evaluated how system quality and user's personality in VR usage might influence behavioural intention. We developed a research model to test the hypotheses. We found that the visual presentation of the tourism destination in a VR system influences the user's behavioural intention. Although the study findings showed that user's openness to experience and social influence correlates with behavioural intention, we cannot prove the correlation between conscientiousness and the attitude to use VR. VR is a growing industry and offers many benefits, especially tourism. However, there is a risk that if the VR developers do not develop high-quality VR content, the users might give up on the whole idea of VR technology. As a result, it will threaten both VR and the tourism industry.

DISCLOSURE STATEMENT

No potential competing interest was reported by the authors.

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