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The Role of VR Shopping in Digitalization of SCM for Sustainable Management: Application of SOR Model and Experience Economy

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Abstract: Shopping malls in virtual reality (VR) environments have created a new paradigm of distribution environments as a strategy of digital consumption experience for sustainable management in the fast-changing digitalization of SCM. This study implemented a VR shopping environment to examine how telepresence and interactivity affect the consumers' usage behavior after experiencing a VR shopping environment by applying the SOM model and experience economy, and suggests the role of VR shopping in the digitalization of SCM for sustainable management. First, this study examined the impact of telepresence and interactivity on time distortion and enjoyment based on the experience economy and flow theory. Second, the relationship between time distortion and perceived enjoyment during the VR shopping experience was tested. The study also examined whether the perceived enjoyment affected behavioral intention. As a research method for this study, we directly implemented a VR supermarket, and had 120 people participate in the survey after experiencing the VR supermarket. Additionally, a structural equation model was used to verify the proposed hypothesis model. The study findings show that both telepresence and interactivity have a significant relationship with time distortion and enjoyment. Time distortion was verified to have partial mediating effects on the relationship between telepresence and enjoyment. Time distortion had a positive impact on enjoyment, which in turn was verified to have a significant effect on the consumers' behavioral intention. In other words, in order to digitize SCM for sustainable management in a VR shopping environment, it is necessary to implement an environment in which consumers are immersed and to track consumer behavior during the experience. Through this, it is possible to create a core management strategy that creates a competitive advantage.

Keywords: VR shopping; telepresence; interactivity; time distortion; enjoyment

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1. Introduction

In the era of the Fourth Industrial Revolution, the application of information and communication technology is playing a key role in transforming society. Specifically, embedding emerging technologies into shopping environments is a major shift in consumer markets that is creating a ubiquitous paradigm for a seamless shopping experience for customers. For instance, the Alibaba Group, which is the biggest online shopping mall in China, has launched a virtual reality (VR) shopping mall by combining VR technology. The corporate emphasizes that with VR technology, consumers can enjoy shopping anywhere in the world without the limitations of temporospatial constraints, indicating the potential of VR technology to create realistic shopping environments. It is expected that shopping environments combining VR technology will create a new shopping paradigm in which experiential elements are combined based on the experience economy, which will lead to "flow" in shopping, unlike the existing shopping paradigm.

As such, some global retailers are attempting the challenge to create a new shopping culture that combines virtual reality technology. However, since the possibility of sustainable management in response to these challenges has not been verified, the reality is that it remains a short-term implementation. In this study, from a long-term perspective, we sought to find important variables for creating consumer experiences for the sustainable management of VR shopping malls, and suggest the role of VR shopping for the digitization of corporate SCM.

The contribution of this study is that it directly implemented a VR supermarket and researched a distribution environment incorporating virtual reality-based new technology beyond the online distribution in the global environment of digital transformation. In addition, in previous studies, many have focused on the new technology acceptance model from the perspective of the acceptance of new technology [1–3]. This study, based on the SOR model, researched the behavior from the subjective shopping experience of practically immersed consumers for corporations. Furthermore, this study suggests the role of VR shopping in the digitalization of SCM for sustainability management.

A review of previous studies related to this subject showed that most of these studies were conducted on the experiences of flow based on online shopping. Pelet et al. argued that telepresence realizes optimal flow experiences and affects time distortion and frequency of use while users use social media [4]. Another study verified that the entertainment elements on the websites of tourism marketing institutions affected telepresence and became elements that induced intimacy and interest in tourist destinations [5].

This study aimed to implement a VR shopping environment—a new form of distribution channel—to enable respondents to experience product purchases in a virtual environment and to review the impact of telepresence and interactivity on the consumers' time distortion and enjoyment as well as their behavioral intention. In addition, the mediating role of time distortion in the relationship between telepresence and enjoyment and between interactivity and enjoyment was investigated to provide a practical perspective for using strategies that are different from the existing channels of distribution.

2. Theoretical Review

2.1. Digitalization of Supply Chain Management and Role of VR

Supply chain management is an integral part of all enterprises and is concerned with the planning, design, implementation, and control of their logistics activities including procurement, warehousing, inventory management, manufacturing, distribution, and order fulfillment [6]. Many corporations are investing heavily, especially to digitize their business models and supply chain management, and as a result, the current supply chain process is going through an accelerated digitalization process [7]. In particular, technology and innovation are accepted as one of the main factors influencing the evolution of the supply chain [8], and one of the new things that has emerged according to such environmental changes is VR. Here, VR is an advanced form of visualization [9], defined as a "real or simulated environment in which a period experience telepresence [10]".

Existing studies suggest that VR is possible to enhance a variety of digital experiences including enhanced repair and maintenance capabilities in manufacturing, warehousing, and logistics for employees and customers. In addition, these immersive technologies can help provide customers with better product visualization as well as store layout and planning for retailers [11]. For example, VR heat mapping technology tracks the shoppers' movements in stores, providing retailers with information about areas or products that appeal to customers, which allows retailers to test and improve retail displays and layouts to strategically optimize the customer experience [12]. Retailers are also using AR technology to provide customers with an amazing and exciting shopping experience. For example, virtual reality (VR)-based Alibaba in China uses VR to overcome time and space constraints and provides new purchasing environments where customers can enjoy shopping anytime, anywhere, if they want.

2.2. SOR Model

According to research in the field of environmental psychology, human behavior is influenced by its surroundings [13,14]. These results also appear in the purchase behavior at stores, and store attributes are considered as one of the variables predicting consumer purchase behavior [15]. One of the representative theories explaining the impact of the environment on in-store consumer behavior is the stimulus organism response (SOR) model.

The SOR model is a theory that various environmental stimuli surrounding the individual affect the individual's psychology and consequently elicit a response as an individual's behavior [16]. Here, stimulation refers to the influence that an individual receives in an external environment, and an organism refers to the psychological state of the stimulated individual. Finally, a reaction is the result of doing a specific action. The key point of this theory is that individual perception of the environment does not directly affect individual behavior, but through the mediation of emotional responses [17,18].

On the other hand, studies applying the SOR model to online/offline retailers argue that environmental cues such as color, lighting, music, crowding, fragrance, and layout affect the customers' internal conditions and external reactions [19,20]. From this point of view, the application of the SOR framework to the VR shopping mall is considered valid. Therefore, in this study, the vividness, interactivity, and control that make up a multidimensional VR shopping mall are defined as stimuli; telepresence and playfulness are defined as organisms; and finally, the VR shopping intention is defined as the response.

2.3. Experience Economy

"Experience" refers to events or phenomena that stimulate consumers in their daily life [13]. Through such experiences, customers build a positive attitude toward the offerings provided by the corporation. In turn, the corporation gains a competitive advantage by providing meaningful and memorable experiences to its customers [21].

Unlike traditional marketing, the experience economy refers to viewing consumption as an experience rather than simply focusing on product purchase. This concept of the experience economy is a new paradigm proposed by Pine and Gilmore [21], who argued for changes in the industry to provide experiences beyond products. In addition, a core aspect of the experience economy is to provide distinct experiences of customer value [22], and deliver experiences that stimulate the sensory awareness related to people's lifestyles [15]. That is, in the experience economy, experience is a process that engages customers directly when they use products and services provided by corporations [23]. In addition, customer experience is becoming an important issue in that it is possible to reinforce the relationship between the customer and the corporate, and customer experiences evoke customer behavior [24]. In this study, the provision of a unique shopping experience, termed VR, is regarded as important not only to induce consumption for product purchases, but also to maximize customer value while using services for a distinct shopping experience.

2.4. Telepresence, Time Distortion, and Flow

The concept of telepresence refers to a subjective state during which the users experience a virtual environment that is different from the real world, that is, a mediated environment, to perceive the virtual environment as a wonderful state, and experience a sense of reality as if they are physically existing objects mediating the environment [25]. The higher the users' level of telepresence, the more immersed they become in the virtual world [4].

Many scholars have argued that people who experience flow experience appear to exist outside of time, as if they were lost in time [26]. This phenomenon is called time distortion, which means that participants who have participated in an experience lose their sense of time and perceive that time has passed quickly [27]. Ornstein argued that successful experiences are better organized in memory than unsuccessful experiences, and that memories of good experiences are perceived as taking less time because they occupy

less cortical space [28]. In other words, the optimal experience is accompanied by a loss of self-consciousness [26].

Flow is about experiencing activities in an optimal state and refers to the overall sensation perceived when the users act in relation to something [29]. A study of the initial state of flow showed that it is an immanently optimized pleasant experience that can be experienced in a psychological state where the sense of challenge and skill are balanced [30]. Flow is a key characteristic and strength of VR experience that is different from general physical experience [27]. Among previous studies, which are based on environments that interact with VR, research on the importance of flow have been conducted [31,32]. The scope of studies on flow has gradually expanded so that the flow theory can be applied to studies across various fields such as user web navigation [33], online games [34], and e-shopping [4].

In the context of the causal relationship between telepresence and flow, scholars have expressed various opinions. Some researchers view telepresence as a leading variable of flow [35,36], while others have argued that telepresence is a component of flow [28,37]. In this study, telepresence is perceived as an important component in the VR shopping environment, leading to a simulated experience that shows the impact of immersion on the users' consumption behavior.

On the other hand, the relationship between time distortion and flow has been a consistent argument. The flow experience causes time distortion due to immersion and concentration during user engagement [38,39]. A VR tourism study by [40] argued that flow is a steady state of inclusive immersion that engages the users' curiosity and distorts time while experiencing VR tourism. In Fang and Huang's study, attention, control, entertainment, and time distortion were presented as factors to measure the user's immersion level [27]. In other words, time distortion is an indispensable subjective perception of the user's flow experience.

3. Research Model and Hypothesis

3.1. Telepresence, Time Distortion, and Enjoyment

For most users, a successful experience is perceived to have lasted for a shorter time than the actual time, unlike a failed experience [41]. The reason for this is that successful experiences are better organized in memory than unsuccessful experiences, and that memories of good experiences are perceived as taking less time by occupying less cortical space [28]. Individual experiences are subjective, and the time perceived by users is not absolute but varies among individuals. Rau et al. argued that consumers tend to perceive that time passes quickly when they conduct activities in which they actively participate and experience moderate psychological pressure [26]. That is, time distortion occurs when consumers become fully concentrated and immersed because they have an enjoyable experience of flow [39]. As such, when users experience a high level of telepresence in a VR shopping environment, they become immersed in shopping activities [4] and this creates a perceptual distortion of time, that is, time seems to pass faster relative to actual time.

In addition, the fact that individuals perceived the activity as an enjoyable experience entails that they were immersed in the flow of the activity [42]. Pace found that when the user's perceived telepresence in a three dimensional virtual environment (3D VR), their curiosity became stimulated to the extent that they forgot what they had planned earlier [43]. Oum and Han showed that users with high telepresence had a higher perceived level of enjoyment [44], thereby revealing an influencing relationship between telepresence and enjoyment.

Hypothesis 1 (H1). *In VR shopping environments, telepresence has a positive (+) influencing relationship with time distortion.*

Hypothesis 2 (H2). *In VR shopping environments, telepresence has a positive (+) influencing relationship with enjoyment.*

3.2. Interactivity, Time Distortion, and Enjoyment

Interactivity indicates the type and degree of contentment that a user experiences in VR [10]. In this study, we examined the level of the users' control and perception of the system and environment. That is, interactivity accomplishes shopping efficiency by making users spend their time voluntarily so that shopping experiences are maximized [45]. Moreover, consumers who shop for fun and enjoyment are rewarded for the time they expend on the activity [46]. According to Cyr et al.'s research, sites where interactivity-type products are displayed or sites where social network services exist and are driven in connection with users, generate higher levels of user enjoyment [47]. This study posits that due to the characteristics of VR shopping environments, the level of interactivity has an influencing relationship on the level of the consumers' perceived enjoyment.

Hypothesis 3 (H3). *In VR shopping environments, interactivity has a positive effect on time distortion.*

Hypothesis 4 (H4). *In VR shopping environments, interactivity has a positive (+) influencing relationship with enjoyment.*

3.3. Time Distortion and Enjoyment

Time distortion has a close relationship with perceived enjoyment because the subjective speed of time perceived by consumers is a phenomenon that appears when the perception is based on a pleasant experience [26]. According to Milliman, a pleasant shopping environment not only increases the consumers' voluntary shopping time, but also the amount spent on shopping [48]. In other words, the reason that consumers spend their time shopping is that it brings the reward of having an enjoyable shopping experience [46]. In the same text, the greater the distortion in the perception of time by consumers, the more pleasurable will be their enjoyment derived from the activity in a VR shopping environment. Thus, based on previous studies, this study posits that the higher the level of the consumers' subjective time distortion in the VR shopping environment, the higher the consumers' perceived enjoyment will be.

Hypothesis 5 (H5). *In VR shopping environments, time distortion has a positive (+) influencing relationship with enjoyment.*

3.4. Enjoyment and Behavioral Intention

The level of enjoyment perceived by users while using a new technology plays a positive role in their attitude toward reusing the technology in the future. Childers et al. emphasized that "Enjoyment is an important leading variable of attitudes in web shopping situations." (p. 526) [49]. Similarly, a study conducted by van der Heijden verified that perceived enjoyment had a positive influence on attitude toward using websites and behavioral intentions [50]. In addition, Kim and Forsythe argued that usefulness and the users' perceived enjoyment had a significant influencing relationship on the intention to use the new technology and attitudes such as evaluation after use [51].

In VR shopping environments, when consumers perceive enjoyment while experiencing interactivity with a new technology, it is standard to evaluate the factors that influence the consumers' behavioral intention in the future. Therefore, this study deems that if consumers who experience a distribution channel that combines the new technology, termed the VR shopping environment, experience enjoyment during the experience, it will have a significant influence on their attitude toward reusing VR shopping in the future.

Hypothesis 6 (H6). *The enjoyment perceived in VR shopping environments has a positive (+) influencing relationship with behavioral intention.*

4. Methodology and Results

4.1. Sample Design and Data Collection

A VR system, similar to a real supermarket, was developed through a specialized VR development corporation. A mini supermarket, corresponding to a real supermarket, was created over a two-month period and participants were invited to wear VR glasses and enter the supermarket to do their shopping using a joystick connected to the sensor, while freely wandering around for about 20 min. Participants were able to see two virtual hands similar to their body from a first-person perspective and carry a shopping basket in one hand and pick up items with the other hand. Immediately after the shopping experience, a questionnaire survey was conducted. Male and female experimenters in their 20s to 40s were selected to conduct the questionnaire survey for a total of 120 respondents. Regarding the characteristics of the sample, as shown in Table 1, 57 participants (47.50%) had experienced VR environments previously, while 63 respondents (52.50%) had never experienced a VR environment. There were 70 males (58.33%) and 50 females (41.67%), with 110 respondents in their 20s (91.67%), eight in their 30s (6.67%), and two in their 40s or older (1.66%). In terms of educational attainment, 77 were four-year college students (64.17%) and 43 were university graduates and graduate school students (35.83%). The residence of the sampled respondents showed that 94 lived in Seoul (78.33%), 23 lived in a metropolitan area (19.17%), one lived in a province (0.83%), and two were from overseas (1.67%).

Table 1. The profiles of the respondents (n = 120).

		Frequency	Percent (%)
Gender	Male	70	58.33
	Female	50	41.67
Age	20s	110	91.67
	30s	8	6.67
	Over 40	2	1.66
Education	University	77	64.17
	Graduate School or Graduation	43	35.83
Job	Student	114	95.00
	Office worker	6	5.00
Residence	Seoul	94	78.33
	Metropolitan area	23	19.17
	Provinces	1	0.83
	Foreign country	2	1.67
Past VR shopping experience	Yes	57	47.50
	No	63	52.50

4.2. Scale Development

This study used a self-reporting questionnaire with a 5-point Likert scale (1 = "strongly disagree" to 5 = "strongly agree"), and the hypotheses were tested with a structural equation model using the AMOS 21.0 program. Telepresence was measured using eight items composed to fit this study and consistent with Kim and Biocca [25] and Pelet et al. [4]. Interactivity was measured using the items developed by Steuer [10]. Time distortion was measured using three items from studies conducted by Hoffman and Novak [35] and Huaung and Liao [52]. In addition, enjoyment was measured using four items each from Childers et al. [49] and Kim et al. [51]. Behavioral intention was measured using six measurement items used by Kim et al. [53] Lee et al. [54] and Kim et al. [51] after composing them to fit the purpose of this study. Therefore, a questionnaire survey was conducted using a total of 24 items after excluding three items for telepresence, one item for interactivity, and one item for enjoyment. Therefore, the analysis was conducted with 19 items. Using the collected questionnaires, reliability was reviewed through Cronbach's

α to refine the measurement, validity was tested through confirmatory factor analysis using AMOS, and the hypotheses were finally tested through mediation analysis using the bootstrapping method.

The operational definitions of the major variables of this study are as presented in Table 2 below.

Table 2. Operational definition of the study constructs.

Construct	Operational Definition
Telepresence	A state where the consumers forget the real situation and experience a sensation of being in a new world while present in a VR shopping mall and feel that they have return to reality the moment the experience ends.
Interactivity	Interactivity in a VR shopping mall is the state where interactions are conducted in the virtual environment, and the consumers can control the activities as they desire and move about freely.
Time Distortion	A state of perception where the consumers feel time is passing quickly, and lose a sense of time during the VR shopping mall experience and are not able to keep track of time, but do not feel the time spent is useless.
Enjoyment	A state where a VR shopping mall experience influences the consumers and tends to make them feel immersed in fun, enjoyment, and interest.
Behavioral Intention	Behavioral intention refers to the consumers' intention to visit VR shopping malls later and use them continuously to purchase products.

4.3. Data Analysis

Confirmatory factor analysis indicated that the measurement model showed adequate goodness-of-fit (χ^2 = 195.01, (p = 0.001), comparative fit index (CFI) of 0.96, incremental fit index (IFI) of 0.96, root mean square residual (RMR) of 0.05, and root mean square error of approximation (RMSEA) of 0.05). As seen in the Table 3, all standardized factor loadings were greater than 0.50. Composite reliability for the model constructs ranged between 0.57 and 0.94.

Table 3. Reliability and validity analysis.

Variable (Reliability)	Items	Factor Loading (R Square)
Telepresence (0.81)	· When I started experiencing the VR shopping mall, a new world unfolded before me, and the moment I stopped experiencing it, that world suddenly disappeared.	0.81 (0.67)
	· While I was experiencing the VR shopping mall, I felt as if I was in a new world.	0.78 (0.61)
	· When experiencing the VR shopping mall, I immediately forgot the surrounding environment.	0.60 (0.37)
	· When the VR shopping mall experience ended, I felt I had returned to reality.	0.69 (0.48)
	· During the VR shopping mall experience, I felt my body was in the room, but my mind seemed to be in the VR shopping mall world.	0.57 (0.33)
Interactivity (0.78)	· I could easily interact with the VR environment.	0.68 (0.46)
	· I could control the surrounding environment as I wished in the VR environment.	0.84 (0.71)
	· I could move about freely in the VR environment.	0.71 (0.50)

Table 3. *Cont.*

Variable (Reliability)	Items	Factor Loading (R Square)
Time Distortion (0.74)	· While I was experiencing shopping in the VR environment, I felt like time was passing very quickly.	0.74 (0.55)
	· I do not think the shopping experience in the VR environment was a waste of time.	0.70 (0.49)
	· The shopping experience in the VR environment made me forget all sense of time.	0.67 (0.45)
Enjoyment (0.91)	· The VR shopping mall experience is enjoyable.	0.88 (0.79)
	· The VR shopping mall experience is exciting.	0.90 (0.82)
	· The VR shopping mall experience per se is amusing.	0.84 (0.71)
	· The VR shopping mall experience kept me immersed while shopping.	0.69 (0.48)
	· The VR shopping mall experience is interesting.	0.79 (0.63)
Behavioral Intention (0.93)	· I will continue to use VR shopping malls for shopping.	0.94 (0.89)
	· I am also willing to visit VR shopping malls for shopping later.	0.93 (0.88)
	· Hereafter, I am willing to purchase products at places where VR shopping malls are operated.	0.83 (0.70)

As seen in the Table 4, the composite reliability and average variance extracted were strong for all the latent variables. In addition, all the model constructs exhibited discriminant validity based on the standards suggested by Fornell and Larcker [55].

Table 4. Confirmatory factor analysis test.

Variable	Estimate (S.E.)	*t*-Value	AVE	CR
Telepresence	1.26 (0.20)	6.25	0.52	0.84
	1.05 (0.17)	6.60		
	1.11 (0.21)	5.11		
	1.05 (0.18)	5.60		
	1	-		
Interactivity	0.81 (0.13)	6.25	0.78	0.81
	1.09 (0.15)	7.28		
	1	-		
Time distortion	1.01 (0.14)	6.86	0.81	0.79
	0.82 (0.13)	6.34		
	1	-		
Enjoyment	1.21 (0.10)	11.35	0.59	0.94
	1.17 (0.10)	33.68		
	1.20 (0.11)	1.62		
	1.06 (0.13)	8.19		
	1	-		
Behavioral intention	1.15 (0.08)	14.17	0.55	0.92
	1.20 (0.08)	13.74		
	1	-		

As presented in Table 5, the squared values of the correlation were shown to be lower than the AVEs. Therefore, in this study, internal consistency, convergent validity, discriminant validity, and nomological validity were secured.

Table 5. Correlation matrix.

Item	A	B	C	D	E
A: Telepresence	0.52 *				
B: Interactivity	0.09	0.78 *			
C: Time distortion	0.48	0.16	0.81 *		
D: Enjoyment	0.45	0.24	0.49	0.59 *	
E: Behavioral intention	0.32	0.12	0.49	0.32	0.55 *

* The diagonal values are AVE.

4.4. Model Testing

This study examined the impact of telepresence and interactivity on the consumers' new flow experience in VR shopping environments. As shown in Table 6, the fit of the structural model was shown to be generally at a good level, where χ^2 = 214.35 (p = 0.000), d.f. = 145, CFI = 0.95, GFI = 0.85, IFI = 0.95, RMR = 0.07, and RMSEA = 0.06.

Table 6. Hypothesis testing results.

Hypothesis	Standard Estimate	S.E.	*t*-Value
H1: Telepresence → Time distortion	0.63	0.16	4.42 ***
H2: Telepresence → Enjoyment	0.21	0.10	1.78 *
H3: Interactivity → Time distortion	0.20	0.10	1.95 *
H4: Interactivity → Enjoyment	0.20	0.06	2.49 **
H5: Time distortion → Enjoyment	0.57	0.11	3.92 ***
H6: Enjoyment → Behavior intention	0.59	0.15	6.21 ***

* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

From the results of the path analysis for testing the study hypotheses, H1 was supported (γ = 0.63, t = 4.42, $p < 0.01$), while H2 was not significant (γ = 0.21, t = 1.78, $p > 0.1$). H3 was supported (γ = 0.20, t = 1.95, $p < 0.1$), and H4 was also shown to be significant (γ = 0.20, t = 2.49, $p < 0.05$). H5 (γ = 0.57 t = 3.92, $p < 0.01$) was also supported because the relationship was shown to be significant. Finally, H6 (γ = 0.59, t = 6.21, $p < 0.01$) was supported. Therefore, the influencing relationships of telepresence and interactivity with time distortion and enjoyment in VR shopping environments were all supported. The results of the analysis of the study models are presented in Figure 1.

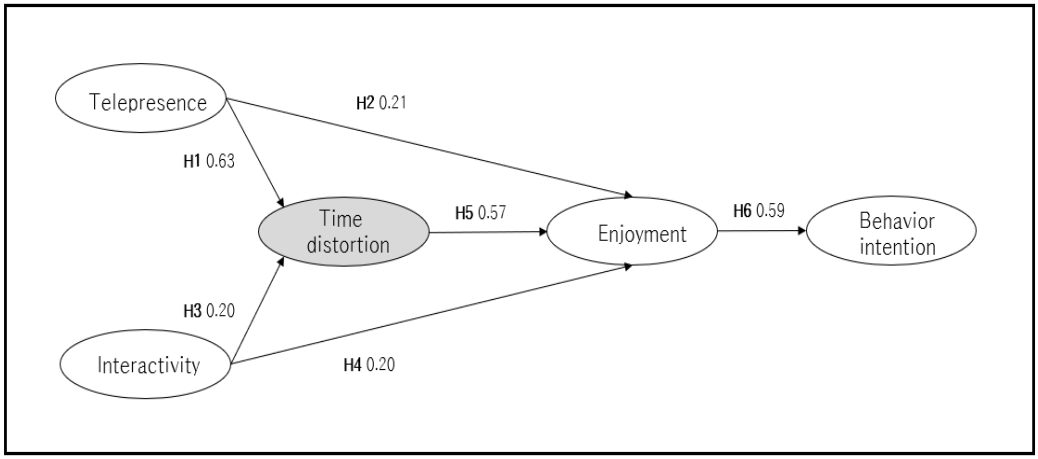

Figure 1. Results of the research model.

4.5. Mediating Effect of Time Distortion

The study model was further analyzed to test the mediating effects of time distortion between telepresence and enjoyment and between interactivity and enjoyment, and the significance of the mediating effects was checked using the bootstrapping method.

On reviewing the analysis results presented in Table 7, it can be seen that telepresence had a significant impact on enjoyment through mediation by time distortion (γ =0.36, $p < 0.05$). In addition, the direct effects of telepresence on enjoyment were significant ($\gamma = 0.21$, $p < 0.1$), but lower than the mediated effects. Therefore, it can be confirmed that time distortion partially mediates telepresence and enjoyment. On the other hand, since interactivity had a greater and direct impact on enjoyment than the indirect effect mediated by time distortion ($\gamma = 0.12$, $p < 0.05$) ($\gamma = 0.20$, $p < 0.05$), no mediated effect was observed.

Table 7. Analysis of the mediating effects of time distortion.

Path	Direct Effect	Indirect Effect	Total Effect	Mediated Effect
Telepresence → Enjoyment	0.21 *	0.36 **	0.57 **	Partially mediated
Interactivity → Enjoyment	0.20 **	0.12 **	0.32 **	none

* $p < 0.10$; ** $p < 0.05$.

5. Discussion and Conclusions

Previous studies related to the VR shopping environment have mainly focused on the technical level for improving telepresence [56–58]. Additionally, the implications for the consumers' technology acceptance of new technologies were presented based on the technology acceptance model theory [1–3]. In this study, in order to focus on the actual experience of consumers, time distortion was used as a mediator to examine the relationship between variables. In addition, this study was to suggest implications for the role of VR shopping malls for the digitalization of SCM from the perspective of corporate sustainability management.

Specifically, we implemented a VR shopping mall environment to verify whether the subjective levels of telepresence and the consumers' interactivity caused time distortion, which affects enjoyment and behavioral intention, using structural equation models.

To conclude, telepresence and interactivity are experiences of the new technology, termed as VR shopping environments, which have direct influencing relationships to time distortion and enjoyment. In addition, a significant influencing relationship was identified between time distortion and enjoyment. Since "experiential elements" are reflected in shopping malls based on VR, there is a need to configure an environment in which consumers have a flow experience while shopping. To experience flow, consumers must be completely immersed in the shopping task, forget the real situation completely, and remain absorbed in the new world. Moreover, consumers must be able to smoothly interact in the virtual environment, control the environment as they would like, and move about freely. If the flow environment is configured, the time distortion phenomenon, in which consumers lose their perception of real-time while experiencing virtual shopping, will likely increase, so the tendency for the frequency of consumption is higher. Likewise, when time distortion is caused, VR shopping environments, which are not restricted by time or space, are expected to provide a strong competitive advantage compared to the conventional online channel. In addition, since consumers perceive the experience of VR shopping malls as pleasurable rather than a waste of time, elements of interest and fun are induced so that the potential for future revisits, instead of one-time visits, increases.

Through the study results, we recommend strategies for the new paradigm of future VR shopping environments and the role of VR shopping in the digitalization of SCM for sustainable management. The fact that consumers enjoy VR shopping mall environments by breaking the limitations of time and space, which is the biggest characteristic of VR shopping mall environments as mentioned earlier, involves infinite potential to form a market. Since the consumers' perception of time flow during the experience becomes the basis for evaluating successful consumption patterns, the above fact raises issues that are different from those existing in online and offline shopping malls. That is, the consumers' experience of enjoyment in using VR shopping malls should be maximized by creating

environments for flow and enhancing temporal value because VR shopping malls are not economic activities designed for consumption; instead they can be identified as experiences in the experience economy in which entertainment activities are conducted. Additionally, implementation of the consumer's immersive environment in VR shopping malls does not simply enhance the value from the consumer's point of view. Consumer behavior tracking in an immersive VR shopping mall environment from an enterprise point of view provides retailers with an opportunity to enhance the efficiency of store management. This is the driving force for creating a sustainable competitive advantage of the company. In other words, the role of VR shopping in the digitalization of SCM is an important core business strategy to create a sustainable competitive advantage. In particular, consumer behavior tracking is necessary for the digitalization of SCM in the VR shopping environment, and for consumer behavior tracking, psychological techniques must be included to realize the consumer's immersed experience in the VR shopping environment. In summary, it should be implemented as an immersive environment by distorting the flow of time as a kind of 'illusion', which allows consumers to feel as if the virtual environment is real. This process needs to be improved through continuous digitalization management of the SCM. In this respect, this study implemented a VR shopping environment directly and provides implications and contributions that contribute toward using strategies in the consumers' consumption process.

This is an a priori study of the consumers' consumption experience in a VR shopping environment. First, with regard to the limitations and proposals for future studies, as the sample consisted of college students in their 20s, future studies could consider using a wider range of generational age groups. Second, more tangible implications for the consumers' consumption behavior can be expected by using psychological and technical elements in various VR environments as independent variables. Finally, if the consumers' purchase behaviors in a VR shopping environment are compared and analyzed based on the characteristics of the purchased product (e.g., practical and luxury goods), it is expected that the study can be further developed into a more in-depth analysis. In future studies, based on the results of this study, it is possible to present an improved VR shopping environment through the digitalization of the SCM and to present specific marketing strategies for sustainable management. In addition, it is expected that it is meaningful study if an attempt is made from a new strategic viewpoint by newly reflecting the results of this study beyond the existing strategic viewpoint of e-commerce (e.g., omni-channel).

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