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Promoting Customers' Augmented Reality Immersion in Restaurants

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Completed Research

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Abstract

With the rapid growth of augmented reality (AR) applications, AR is set to influence companies and organizations in every industry. This study focuses on identifying how AR technology enhances memorable experiences through the lens of customer immersion. An AR 3D food ordering platform that included an AR food ordering app for customers and a restaurant management system for restaurants was implemented as part of the study, and the concept of AR immersion was further introduced. The investigation involved an empirical examination of the effects of perceived playfulness and personal innovativeness on three dimensions of AR immersion: engagement, engrossment, and total immersion. The results of an analysis of data collected from 343 restaurant customers who experienced using the AR food ordering app indicated that engagement and engrossment had direct effects on customer satisfaction, but total immersion did not. Perceived playfulness directly affected engagement, engrossment, and total immersion and indirectly affected customer satisfaction through its direct effects on engagement and engrossment. Similarly, personal innovativeness influenced customer satisfaction indirectly through its direct effects on engagement. In terms of the effects of AR immersion, engrossment should be the target, engagement is insufficient, and total immersion is unnecessary. A practical implication of our findings is that it is possible to increase customer satisfaction directly by increasing the levels of engagement and engrossment with an AR food ordering app.

Keywords

Augmented reality immersion, perceived playfulness, personal innovativeness, customer satisfaction.

Introduction

Augmented reality (AR) technology, which blurs the boundary between the real world and virtual worlds, is becoming increasingly prevalent in our daily lives (Suh et al. 2018). More and more AR applications are being applied in many industries, including the automotive; health care; retail and consumer product; industrial product; financial services; hospitality and leisure; construction safety (Li et al. 2018); and technology, media, and telecommunications industries. By placing digital images and data over real objects, AR enables people to handle physical and digital data at the same time and to absorb information more quickly, thus enhancing human decision making. In doing so, the efficiency and accuracy of specific tasks is greatly improved. Instead of 2D monitors and screens, AR will become the "new interface" for people to interact with machines by superimposing digital data directly on the real 3D world (Porter et al. 2017). Thus, AR is on its way to influencing companies and organizations in every industry. We can foresee strong growth of AR applications in the future.

Companies increasingly rely on interactive technologies to improve the customer experience. As the applications of AR are moving from the laboratory into consumer markets (Daponte et al. 2014), this study intends to investigate how companies improve the customer experience using AR technology. It is necessary to figure out the features of such specific experience in advance. In the literature, AR technology has been good at creating successful immersive experiences (Georgiou et al. 2018). Users actively participate in using

AR, rather than being passive consumers. Companies need to take actions that enhance the customer's levels of immersion. Thus, this study is focused on identifying how AR technology enhances memorable experiences through the lens of customer immersion.

In consumer industries, customer experience management has become the most promising marketing approach, which includes touchpoint journey design and touchpoint prioritization, in order to achieve and sustain long-term customer satisfaction and loyalty (Homburg et al. 2017). Companies need to plan potential touchpoint journey and direct the constant implementation and modification of touchpoints with the allocation of monetary, technical, and human resources if customers' memorable experiences are desired. As mobile devices have emerged as one of the most promising platforms for AR, the increased usage of mobile devices has enabled AR apps to reach the customers. The potential of AR technology is to capture customers' attention and influence their purchasing decision. AR's media characteristics, such as sensory immersion, navigation, and manipulation, have been proven to lead to positive emotions and better outcomes (Wu et al. 2013). However, unless we gain a better understanding of the perceptual and cognitive effects of AR apps, memorable customer experiences cannot be designed.

Several world-leading enterprises such as Amazon, Facebook, and GE have proved AR's significant impact on productivity and customer satisfaction. Currently, companies widely build AR product items into their own apps. In the study, AR technology was expected to bring something new to the in-store experience. As many restaurants have adopted mobile devices and other various technologies into their stores, a growing trend of food services with apps is obvious. Indeed, visual representations will help to break down the language and cultural barriers, and customers will have more confidence to try other new or mysterious dishes. Hence, the study intended to establish an AR app with highly interactive functions in the context of a restaurant. The AR app for restaurants integrates prices and recipes information into menu items using information boxes paired with the 3D food models. Besides, the AR app allowed customers to use virtual controls that were visually superimposed on the 3D food models. Hence, customers' experiences were expected to be enriched by means of using the AR app.

The study involved the implementation of a 3D AR menu and ordering system, which was an AR 3D food ordering platform, including an AR food ordering app for customers and a restaurant management system for restaurants. The AR food ordering app was relatively easy to access and use, as shown in Figure 1. It enabled customers to engage with virtual information superimposed on the physical world, augmenting their experiences and interactions (Rochlen et al. 2017). Customers were excited to use it because it was novel. Thus, they were predicted to enjoy such AR interaction, and their perceived playfulness could be observed. Besides, the AR food ordering app created virtual food displays consisting of multiple digital elements and information, and placed them in a new AR menu. Restaurants were able to provide customers with detailed information of meals. All 3D model dimensions were identical to the food and display an accurate representation of appearance. Thus, customers were able to view the 3D food models, and to have a clear preview of a menu item's outlook, description, presentation as well as ingredients both inside and outside the physical location. When relevant and useful product information was displayed in the physical world with the real product, customers became more knowledgeable and increased their understanding of the product. They came to a satisfactory choice: whether to buy or not to buy. After implementing the 3D AR menu and ordering system, the study further examined the customers' satisfaction of the AR food ordering app.

The study investigated the effects of customer immersion in AR technology on customer satisfaction in the context of a restaurant that gave customers the opportunity to use the AR food ordering app. As the study participants were customers at the specific restaurants, their satisfaction of the AR food ordering app was evaluated in advance. Besides, this study included perceived playfulness and personal innovativeness as two critical factors in explaining customers' AR immersion, after considering that the subjective nature of immersion can be affected by personal characteristics. Hence, this study intended to answer the following questions. Does an AR food ordering app enhance customers' immersion? Which types of AR immersion are significantly affected?

Figure 1. The AR Food Ordering App

Literature Review

This study investigated how companies improve the customer experience by applying AR technology. It is necessary for the study to figure out the features of such specific experience in advance. In the literature, AR technology has been good at creating a successful immersive experience (Georgiou et al. 2018). Users actively participate in using AR, rather than being passive consumers. Thus, the study needs to identify how AR technology enhances memorable experiences through the lens of customer immersion.

AR immersion

Three categories of AR applications have been identified and summarized (Ibáñez et al. 2018), namely simulation tools, games, and exploration applications, which were further divided into augmented books, augmented marks, and the use of a point of interest to trigger digital information. Most of AR applications were triggered by image-based AR technology such as markers (Frank et al. 2017), whereas few of them were location-based (Chen et al. 2018). Theses AR applications applied plenty of digital information to augment the real world, such as text, 2D images, animations, audio information, videos, 3D objects, and even hyperlinks to the World Wide Web. Most than half of the applications demonstrated unique AR features by using multiple types of digital elements simultaneously. However, these AR applications are progressively differentiated in terms of details and only focused on "presentation" of digital information. The interactive characteristic of AR technology should be further manipulated.

Highly interactive designs of AR technology have been used to allow users to become immersed in environmental exploration (Huang et al. 2016). For example, Ibáñez et al. (2016) have presented an interactive AR application by allowing users to interact with 3D digital objects and to give immediate feedback. In addition, AR-based simulators have been effectively used for people to understand science content in science museums (Yoon et al. 2017). In doing so, AR technology has more opportunities to create immersive experiences.

In the literature on digital applications, immersion is first defined as the users' suspension of disbelief that they are inside a digitally enhanced setting (Dede 2009). In the fields of entertainment and e-learning,

users' digital experiences are related to the degree of immersion, which is the degree of their cognitive and emotional engagement with a specific digital application (Cheng et al. 2017). In this regard, immersion has been well defined as a multi-level continuum of cognitive and emotional involvement.

Georgiou et al. (2017) further examined immersion in the context of AR settings and proved that AR immersion consisted of three sequential stages—engagement, engrossment, and total immersion—by developing and validating the Augmented Reality Immersion (ARI) questionnaire. In practice, three levels of immersion can be measured using the ARI questionnaire. The lowest level is engagement, which represents users' interest in and usability of the AR application. The middle level is engrossment, which refers to users' emotional attachment and focus of attention. Total immersion is the highest level of immersion and measures users' level of presence and flow. The ARI questionnaire offers the study a consolidated theoretical measurement of immersion in AR settings, and appears to be a promising tool for the study to assess immersion in the context of using AR applications (Georgiou et al. 2018).

Currently, companies widely build AR product items into their own apps. Most AR applications, such as an AR-enhanced furniture catalog or an AR-enhanced food menu, demonstrate only basic product representations with 2D images, while some use 3D models. However, further information and more interactive functions seem to be missing from AR apps. For example, AR apps for restaurants can integrate prices, recipes, and nutrition information into menu items using information boxes paired with the 3D food models. Furthermore, a restaurant AR program allows customers to use virtual controls that are visually superimposed on the 3D food models, rather than using physical controls such as buttons and knobs. It is difficult to present further information on 3D food models or to calculate the amount of customers' detailed interactions. This limits the use of AR technology for the proposed study. Therefore, we need to establish an AR food ordering app with highly interactive functions. By doing so, the study is able to examine the satisfaction of the specific AR application, namely the AR food ordering app.

In the study, AR technology is expected to bring something new to the in-store experience. A restaurant was the chosen context for the study. Hence, a 3D AR menu and ordering system was implemented in the study. The system is a new AR 3D food ordering platform, including an AR food ordering app for customers and a restaurant management system for restaurants. After customers download the AR food ordering app onto their mobile devices, they point the devices at a food item on the menu. The AR food ordering app will recognize it, using computer vision technology to analyze the food image. The devices then automatically download the 3D model of the food item from the AR Vuforia platform. The AR information will be presented in a 3D format superimposed on the food item. In practice, all 3D digital food models in the AR Vuforia platform can be created using technology that digitizes physical objects, such as 3D scanning technology. The AR information that the customer sees came partially from the AR Vuforia platform and partially from the restaurant management system. More specifically, the AR food ordering app collects the 3D food model from the AR Vuforia platform and obtains up-to-date information from the restaurant management system to reflect the food item's current reality.

When people are engaged in an activity, they are engaged in the process of that activity. This state of engagement can be activated and motivated through the use of cognitive strategies to expedite comprehension (Mollen et al. 2018). The effects of such engagement have been explored in the literature. For instance, Mollen et al. (2018) showed how online engagement had positive effects on users' attitudes and behaviors. As engagement has been treated as a cognitive and affective commitment to an active relationship with a brand, higher engagement leads to greater positive effects from such interactions.

Customer Satisfaction

Satisfaction has been identified as a crucial aspect in the quality of buyer-seller relationships (Barroso-Méndez et al. 2015). Satisfaction refers to buyers' affective state regarding their overall appraisal of the service experience. The best way for companies to attract customers and make a lasting impression is to deploy an AR app in stores to enable customers to experience the brand in a unique way. In e-commerce, IKEA enables online shoppers to integrate 3D product images onto a view of their personal rooms using its AR app, the AR-enhanced furniture catalog. Customers thus have more confidence in evaluating how furniture will look in their rooms. Xerox has applied AR technology to help customers solve technical problems themselves by remotely connecting them to experts. Surprisingly, customer satisfaction rates have risen to 95% (Porter et al. 2017). Besides, AR's media characteristics, such as sensory immersion, navigation, and manipulation, have been proven to lead to positive emotions, better outcomes (Wu et al.

2013), and customer satisfaction (Poncin et al. 2014). Hence, immersion has been argued to have a positive effect on customer outcomes. This observation leads to the following hypothesis.

Hypothesis 1: AR immersion is positively related to customer satisfaction.

As AR immersion has three dimensions of engagement, engrossment, and total immersion, hypothesis 1 is expanded as follows.

Hypothesis 1a: Engagement is positively related to customer satisfaction.

Hypothesis 1b: Engrossment is positively related to customer satisfaction.

Hypothesis 1c: Total immersion is positively related to customer satisfaction.

Perceived playfulness

The information systems literature has demonstrated that users' perceived enjoyment is essential usage. For example, Liaw et al. (2003) found that users' perceived enjoyment was an important factor affecting the decision to use search engines as an information retrieval tool. Lee et al. (2005) showed that perceived enjoyment significantly influenced students' intention to use Internet-based learning media. Yu et al. (2005) found that perceived enjoyment was the most important factor affecting behavioral intention toward electronically mediated commerce using interactive television. Extending the concept of perceived enjoyment, Moon et al. (2001) proposed perceived playfulness as a more comprehensive set of motivation states, including the three constructs of concentration, curiosity, and enjoyment. This study adopts perceived playfulness and treats it as an antecedent of behavioral intention and customers' AR immersion.

The AR food ordering app implemented in this study is relatively easy to access and use. It enables customers to engage with virtual information superimposed on the physical world, thereby enhancing their experiences and interactions (Rochlen et al. 2017). Customers will be excited to use it because it is novel. Thus, they are predicted to enjoy their interactions with this AR food ordering app. Martocchio et al. (1992) found that users who experienced a higher degree of playfulness showed higher affective responses to computer training tasks. Thus, perceived playfulness should lead to users having an immersive experience when using AR applications. Based on the preceding argument, the following hypothesis is proposed.

Hypothesis 2: The higher the level of customers' perceived playfulness, the higher the level of their AR immersion when using the AR food ordering app.

As AR immersion includes three dimensions, namely engagement, engrossment, and total immersion, hypothesis 2 is expanded as follows.

Hypothesis 2a: The higher the level of customers' perceived playfulness, the higher the level of their engagement when using the AR food ordering app.

Hypothesis 2b: The higher the level of customers' perceived playfulness, the higher the level of their engrossment when using the AR food ordering app.

Hypothesis 2c: The higher the level of customers' perceived playfulness, the higher the level of their total immersion when using the AR food ordering app.

Personal Innovativeness

According to the diffusion of innovation theory, personal innovativeness is a critical factor in predicting users' adoption of new technology. People with stronger novelty-seeking motivation may show a greater willingness to adopt an innovation (Hirschman et al. 1980). Personal innovativeness not only leads to the use of new technologies, but also helps to make them available to the wider population. For example, Lin (2004) proved the relationship between the use of webcasting and user innovativeness, which is similar to the concept of personal innovativeness. As users begin to actualize their desire for innovativeness, they may search for and seek to stay current with innovative ideas (Lin 2004). This phenomenon reflects a need for innovativeness. Customer innovativeness matters in the present study, because it presents an innovative service through which restaurants can adopt a three dimensional (3D) AR menu and ordering system. Hence, this study investigates the effect of customer innovativeness on the degree of customers' AR immersion when using the AR food ordering app. The following hypothesis is proposed.

Hypothesis 3: Customers' personal innovativeness is positively related to their degree of AR immersion when using the AR food ordering app.

As AR immersion has three dimensions of engagement, engrossment, and total immersion, hypothesis 3 is expanded as follows.

Hypothesis 3a: Customers' personal innovativeness is positively related to their degree of engagement when using the AR food ordering app.

Hypothesis 3b: Customers' personal innovativeness is positively related to their degree of engrossment when using the AR food ordering app.

Hypothesis 3c: Customers' personal innovativeness is positively related to their degree of total immersion when using the AR food ordering app.

This study examines the effect of customers' personal innovativeness on their AR immersion while using the AR food ordering app. The direct effect of customers' perceived playfulness on AR immersion and the direct effects of AR immersion on satisfaction are measured. Figure 2 shows a summary of the research model.

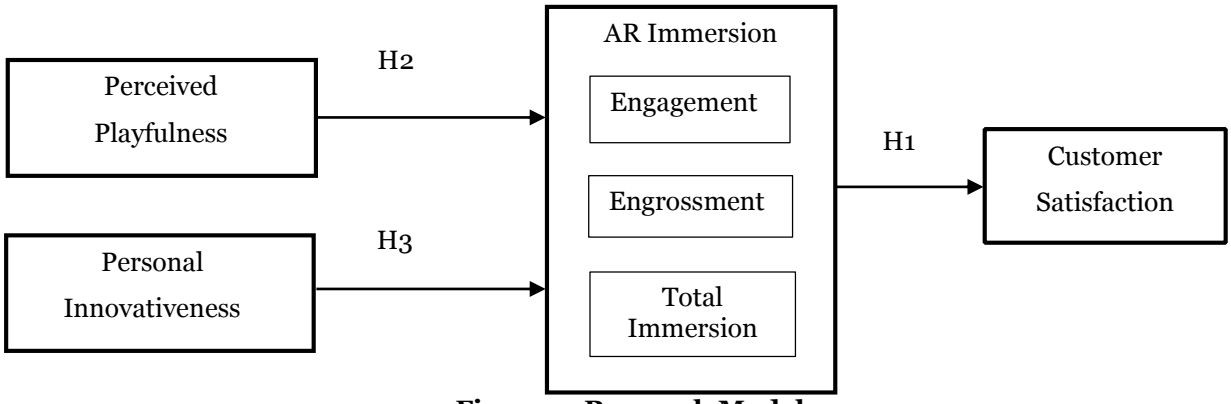

Figure 2. Research Model

Research Method

A 3D AR menu and ordering system was implemented in this study. The system was an AR 3D food ordering platform. It included an AR food ordering app for customers and a management system for restaurants.

AR Food Ordering App

After customers download the AR food ordering app on their camera-equipped devices, such as a smartphone or a tablet, they can point the device at a food item on the menu. The AR food ordering app recognizes the item, using computer vision technology to analyze the food image. The device then automatically downloads a 3D model of the food item from the AR Vuforia platform, similar to how a Web browser downloads a webpage through a URL. Instead of showing a traditional a two-dimensional page on a screen, the AR information is presented in a 3D format superimposed on the food item. In practice, all 3D digital food models in the AR Vuforia platform can be created using technology that digitizes physical objects, such as 3D scanning technology. The AR information that the customer sees comes partially from the AR Vuforia platform and partially from the restaurant management system. The AR food ordering app collects the 3D food model from the AR Vuforia platform and gathers up-to-date information from the restaurant management system to reflect the food item's current reality.

Participants

An investigation followed the implementation of the 3D AR menu and ordering system. The 3D AR menu and ordering system was designed for use in the study context of US restaurants. We recruited 360 participants who had experience with using the AR food ordering app in a restaurant. The participants were

customers of the target restaurant. After downloading the AR food ordering app, the customers had to open the app and point their mobile devices at the menu to launch the AR experience. The AR food ordering app enabled the customers to see virtual 3D food on their tables when ordering in the restaurant. The customers were able to check their meal's status through the real-time interface of the AR food ordering app. They could also send reminders to the restaurant management system by pushing the "check" button if their meal was late.

Procedure

This study administered a questionnaire survey to the participants to assess their degree of AR immersion, perceived playfulness, personal innovativeness, and satisfaction when using the AR food ordering app to browse virtual 3D food and complete their orders. The participants were informed that they were involved in a research project in which they needed to complete a questionnaire about their ordering experiences using the AR food ordering app. However, they were blind to the research hypotheses. The research model shown in Figure 2 was tested using the collected survey data.

Measurement

The dependent variable in this study was customer satisfaction. The independent variables in this study were customer AR immersion, perceived playfulness, and personal innovativeness. The variables were measured on a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). The measurement of each construct is further described as follows.

Customer satisfaction. Dagger and O'Brien (2010) developed a scale to assess relationship quality as perceived by users. It involves summaries of previous measurements of satisfaction (five items), trust (five items), and commitment (seven items). Referencing Dagger and O'Brien's scale, we adapted appropriate items of interest to measure customers' satisfaction levels with the AR food ordering app. The Cronbach's α value for this five-item measure was 0.964.

AR immersion. Georgiou and Kyza (2017) developed the Augmented Reality Immersion (ARI) questionnaire, which consists of 21 items, to measure the status of users' cognitive and emotional absorption while using AR applications. Three dimensions are included in the ARI: engagement (eight items), engrossment (six items), and total immersion (seven items). The ARI scale shows a high level of reliability and generalizability (Georgiou et al. 2017; Georgiou et al. 2018). Hence, we adopted this scale to measure customers' perceived immersion with the AR food ordering app, with a few modifications. The Cronbach's α values for engagement (eight items), engrossment (six items), and total immersion (seven items) were 0.908, 0.905, and 0.931, respectively.

Perceived playfulness. Moon and Kim (2001) developed a measurement of perceived playfulness to identify its three key aspects: concentration, curiosity, and enjoyment. This study adopted Moon and Kim's measurement items to gauge customers' perceived playfulness. The Cronbach's α value for this nine-item measure was 0.952. This study defines perceived playfulness in terms of the degree to which individuals' statements relate to their perception of concentration, curiosity, and enjoyment while using the AR food ordering app.

Personal innovativeness. Lin (2004) developed a scale to evaluate customers' personal innovativeness, which is defined as their desire for innovative ideas, products, or services. The adapted scale contains three

	1	2	3	4	5	6
1. Perceived playfulness	1					
2.Personal innovativeness	.640**	1				
3. Engagement	.715**	.590**	1			
4. Engrossment	.862**	.599**	.769**	1		
5. Total immersion	.884**	.584**	.735**	.866**	1	
6. Customer satisfaction	.811**	.709**	.729**	.763**	.780**	1

Table 1. Correlations Between Variables Note. **p<.01.

items, which measure the degree of a customer's interest and involvement in keeping up with the progress of the AR food ordering app. The Cronbach's α value for this three-item measure was 0.954.

Results

Of the 360 restaurant customers who experienced using the AR food ordering app, 343 completed the online questionnaire without missing data, giving a response rate of 95.3%. The correlations between the variables were tested using Pearson's correlation coefficient. As shown in Table 1, all of the variables were positively interrelated. In addition, the three dimensions of AR immersion, engagement, engrossment, and total immersion, were highly correlated ($r > 0.6$). As we expected, AR immersion showed a high composite reliability and internal consistency.

Using the 343 records, the research model was assessed with maximum likelihood estimation using IBM SPSS Amos. All of the calculations were based on the covariance matrix of the variables. Three common model-fit measures were used to assess the proposed model's overall goodness of fit, the ratio of χ^2 to degrees of freedom (CMIN/DF), comparative fit index (CFI), and root mean square error of approximation (RMSEA). The results indicated that the proposed model (CMIN/DF=2.806; CFI=0.918, RMSEA=0.073) had a good fit. All of the criteria were better than the recommended values (CMIN/DF < 3; CFI > 0.90, RMSEA < 0.08). Thus, we used the model to examine our hypotheses.

As shown in Figure 3, the standardized path coefficients running from both engagement and engrossment to customer satisfaction were statistically significant, thereby supporting Hypotheses 1a and 1b. Unexpectedly, the standardized path coefficient from total immersion to customer satisfaction was not significant. Thus, Hypothesis 1c was not supported. Furthermore, all the standardized path coefficients running from perceived playfulness to the three dimensions of AR immersion (engagement, engrossment, and total immersion) were significant, confirming Hypotheses 2a, 2b, and 2c. Except for the path to Engagement, none of the standardized path coefficients running from personal innovativeness to the three dimensions of AR immersion was significant. Thus, Hypothesis 3a was supported, but Hypotheses 3b and 3c were not.

The R^2 value indicated that 75% of the variance in customer satisfaction was explained by the variables of perceived playfulness, personal innovativeness, and the three dimensions of AR immersion. Furthermore, 74% of the variance in engrossment and 71% of the variance in total immersion were explained by perceived playfulness and personal innovativeness, whereas 67% of the variance in engagement was explained. These results show that two of the dimensions of AR immersion, engagement and engrossment, had direct effects on customer satisfaction, but total immersion did not. Perceived playfulness directly affected engagement, engrossment, and total immersion and indirectly affected customer satisfaction through its direct effects on engagement and engrossment. Similarly, personal innovativeness influenced customer satisfaction indirectly through its direct effects on engagement.

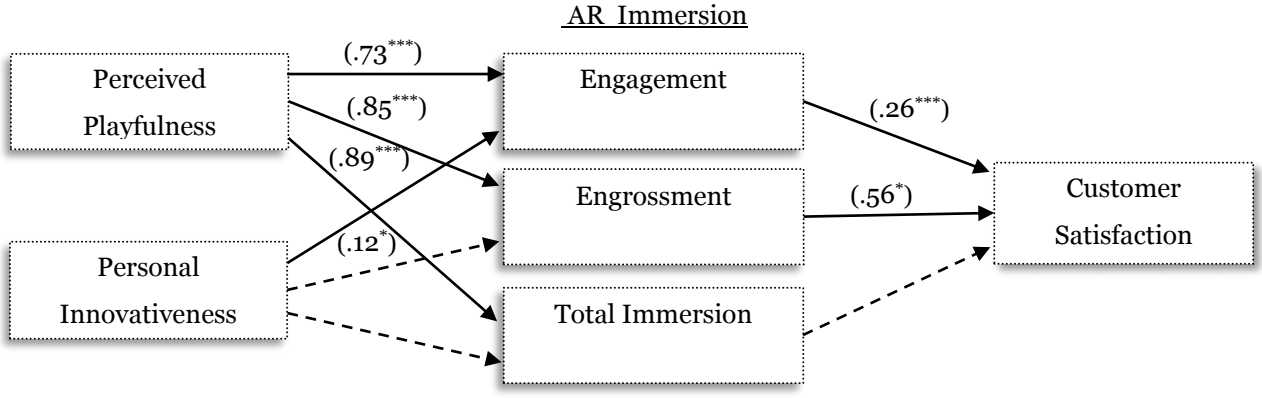

Figure 3. Standardized Path Coefficients of the Proposed Model

(Note: *p<.05, ***p<.001. The dotted lines indicated not statistical significant)

Conclusion

This study measured restaurant customers' perceptions of AR immersion to assess their effects on customer satisfaction when using a 3D AR menu and ordering system. The concept of AR immersion was introduced, and the investigation involved an empirical examination of the effects of perceived playfulness and personal innovativeness on the three dimensions of AR immersion, namely, engagement, engrossment, and total immersion.

Overall, perceived playfulness showed positive effects on engagement, engrossment, and total immersion. Personal innovativeness only had a positive effect on engagement, which in turn directly affected customer satisfaction. Excluding total immersion, the dimensions of AR immersion positively affected customer satisfaction. Based on these findings, we can confirm that the use of the AR food ordering app can increase customer satisfaction by deepening engagement and engrossment and triggering greater perceived playfulness in restaurant customers when their personal innovativeness is not easily exaggerated.

By providing a 3D AR menu and ordering system, restaurants can create greater perceived playfulness for consumers. Creating an AR immersion environment by using the AR food ordering app is an effective way to increase consumer satisfaction by promoting perceived playfulness.

Surprisingly, total immersion did not have a direct effect on consumer satisfaction. For customers in the restaurant context, the different aspects of AR immersion (engagement, engrossment, and total immersion) were clear. In fact, these features show different levels of immersion, with total immersion referring to the highest level of AR immersion. The evidence does not support the relationship between total immersion and customer satisfaction. Customers' AR immersion did not necessarily lead to their satisfaction. A plausible explanation for this result is that consumers are not restricted to the time of using the AR food ordering app in the restaurant. Their engagement with the AR food ordering app and these virtual 3D food objects was time limited. We believe that it takes longer for AR users to reach the status of total immersion. When the participants engaged with the AR food ordering app, they eagerly interacted with the virtual 3D food objects. However, once they became "totally immersed" with the AR food ordering app, they spent more time on it and postponed ordering. Perhaps, this outcome rarely leads to positive satisfaction. Nevertheless, when the customers' heightened engagement and engrossment resulted in greater AR immersion, their satisfaction increased.

Companies expend a great deal of effort to promote their customers' satisfaction to create impactful outcomes in the form of company profit. Successful marketing practices should transform customer engagement into satisfaction. Hence, an important practical implication of our findings is the ability to increase customer satisfaction directly by creating higher levels of engagement and engrossment through using the AR food ordering app.

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