International Journal of Engineering Trends and Technology
ISSN: 2231 – 5381 / https://doi.org/10.14445/22315381/IJETT-V70I5P204

Volume 70 Issue 5, 24-29, May 2022

Original Article

Developing and Evaluating AR for Food Ordering System based on Technological Acceptance Evaluation Approach: A Case Study of Restaurant's Menu Item Selection

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Received: 23 January 2022 Revised: 31 March 2022 Accepted: 24 April 2022 Published: 19 May 2022

Abstract - *Nowadays, people are more concerned about how attractive the dining place is in terms of its services regardless pre or post ordering process. There are just a handful of AR apps available for restaurant ordering systems, given the evolution of numerous Augmented Reality (AR) applications in various fields. In this study, the current trend of AR technology for food ordering systems was investigated to develop a food ordering system using AR for restaurant menu item selection (MenAR). Marker-based technique on the conventional menu was used in this MenAR to visualize 3D food models. Pilot research was executed to evaluate users' acceptability of MenAR using the Unified Theory of Acceptance and Use of Technology (UTAUT). Multiple regression analysis was used to analyze all of the data from the questionnaires. The result later advocated that the suggested factors explained 82.4% of users' intention to use MenAR in the future respondents involved. Performance Expectancy (PE) was the strongest determinant. Overall, MenAR can give an engaging and dynamic information experience. Furthermore, further constructions can be explored to understand better differences in various fields covering the food industry.*

Keywords - *Technological acceptance evaluation, UTAUT, Augmented reality, Food ordering system.*

1. Introduction

In the last decade, various new technologies related to Information and Communication Technology (ICT) have emerged for promoting various fields. One of the new technologies is regarding augmented reality (AR) which is currently becoming the most exciting research study [21]. This is because AR helps better understand the concept of certain topics [15]. This technology provides users with an intuitive interaction, navigation, and manipulation [23]. Users can navigate an immersive virtual environment by manipulating virtual items in real-time [22,19].

In the past research by [17], Multimedia, 3D-Motions, Real-time Tracking and Registration, Sensory, and Intelligent Interplay are all used in Augmented Reality (AR). The basic target of this AR technology is to bring computer-generated virtual details such as representations, text, 3D models, music, and video into the actual world through simulation, whereby these two different particulars complement one another to attain intensification of the real world.

In correlation to that, [1] in her study stated that Augmented Reality (AR) improves the perception among users and their interaction to the real world where the virtual elements will show details that users are not capable of creating by one's consciousness. Two main platforms are presently used for portraying Augmented Reality (AR) information, such as AR-enabled Head Mounted Display (HMD) and handheld devices like smartphones and tablets. Regardless of the smartphone being claimed to show less end experience for the users, it is the most customary channel to practice AR in the market [8].

AR is an innovation that integrates reality and computer-generated digital information into a single physical and interactive real-world environment for a user (19, 28,29). To be more exact, augmented reality (AR) allows users to view three-dimensional simulated items in real circumstances. [12] bringing along both the real and virtual worlds together seamlessly. Moreover, AR itself was previously studied in many aspects by the academician in its business-oriented approach.

Nevertheless, AR is an influential promotional instrument because it offers a different level of visual representation and active participation, which may enhance brand identity and advertising efforts in particular [6]. As a result, augmented reality is viewed as a persuasion technique rather than a useful tool that enhances the user's experience [20]. Apart from being a source of amusement, efficiency, visual appeal, and playfulness, it's also a beneficial creation. [23].

[5] expanded the possibilities of augmented reality in a museum setting while [20] looked into the visual aspects of AR. Furthermore, [10] learned that utilizing augmented reality to learn mathematics increases students' motivation and achievement. [19], on the other hand, looked at using augmented reality to kickstart active learning and encourage inventive and creative thinking. Despite AR being used in many sectors, the benefits and influence of augmented reality in food ordering systems are still under research with a lack of knowledge upon it.

There is very little past literature on Augmented Reality for food ordering systems. However, restaurants are expected to prioritize AR technology and improve the overall restaurant experience through food delivery. Digital menus [24], which integrate such limitations as respondents' involvement, are viewed as a behavioral trait but not as a process. Apart from that, diners will be able to have a more immersive culinary experience by using AR to let them picture what their options will look like before ordering them [7], which depicts a more user-friendly and interactive way of ordering instead of the conventional one.

In terms of the technology acceptance evaluation for the developed, various theories and models have been created to understand users' acceptance and intention to use technologies fully. According to [2], measuring behavioral intention allows them to estimate the performance of any willful choice.

The Technology Acceptance Model (TAM), a major and influential theory of human behavior, was developed to describe the motivating process that conciliates system attributes and user behavior and to relate personal preferences on whether or not to adopt any particular technologies while working on a task [9]. Meanwhile, [15] proposed a technology-to-Performance Chain model whereby This Model emphasizes the interaction of frameworks, reflecting the impact of IT on task performance. Furthermore, [29] recommended the Unified Theory of Acceptance and Use of Technology (UTAUT). This theory explained 70 percent of the discrepancy in behavioral aim when using technology and 50 percent in technology utilization.

2. Related Works

A few studies evaluated Augmented Reality using the Unified Theory of Acceptance and Use of Technology (UTAUT). According to [16], Augmented Reality smart glass apps can stimulate initiatives in the healthcare industry sector by allowing healthcare providers to document operations while performing them without using their hands. Apart from that, [18] developed MARLCardio, which provides an innovative learning environment by enhancing learning experiences through the active engagement of superimposing augmented reality (AR) digital content onto the real environment. Furthermore, [27] in their study made concrete recommendations and investigated an integrative theoretical framework aimed at determining the importance of certain parameters that allow mobile AR apps to be used in shopping malls. The 3D AR models were installed in a smartphone as an AR application that conveys the ancient sites in Melaka's UNESCO World Heritage Site. Moreover, [17] developed AR in archaeological sites targeted to learning behavioral intention to use AR technology in archaeological sites. At the same time, [26] adopted AR in smart tourism to benefit both suppliers and tourists.

3. Materials and Methods

3.1. MenAR Model

Figure 1 shows a MenAR Model where 3 stages are defined to propose this AR application. Augmented reality and food ordering systems are the two studies prioritized at the beginning stage of the MenAR model. These two studies supported the development of AR applications for food ordering systems in the case study of a restaurant's menu item where marker-based was set as the main technique. Android (SDK), Unity 3D, and Vuforia were applied to construct this project. Vuforia is an SDK that many developers utilize to employ AR applications [3]. The application can recognize a wide range of things using the Vuforia SDK, including photos, 3D objects, etc. Unity 3D is a piece of software that allows you to create and implement 3D models by connecting them to the Vuforia SDK, allowing you to synchronize and construct Augmented Reality apps [14]. The project package's file format was in the form of .apk, which was created using the Android SDK, which depicts the mainstream technology for Androids. This study employed UTAUT as the technology acceptance paradigm to evaluate the users' acceptability of the MenAR application after it was developed, whereby four different items were adapted: Facilitating Conditions, Social Influence, Effort Expectancy, and Performance Expectancy.

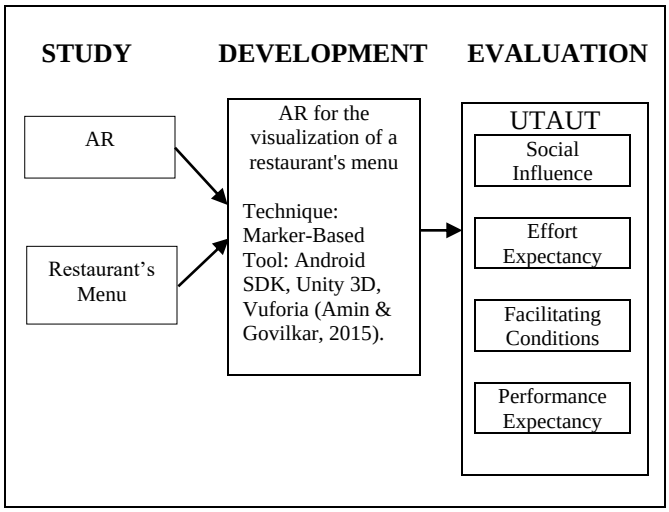

Fig. 1 MenAR Model

3.2. Experiments

Effort Expectancy, Social Influence, Performance Expectancy, and Facilitating Conditions are four components from the Unified Theory of Acceptance and Use of Technology [28] that are encompassed in this study, where each of the items brings out three operational variables to ascertain the users' concession of the Augmented Reality application for food ordering system in the case study restaurant's menu item, known by the name of Men AR.

The development of MenAR focused on the 2D marker and 3D model to eventually provide the AR application for a restaurant's menu item selection. The MenAR app was created using a normal AR flow starting from setting up the 2D Model as a marker and a 3D Model that allows for video and camera capture, overlaying, marker tracking, and virtual object rendering, all from within an Android smartphone.

Furthermore, the 2D markers conform to conventional restaurant menus were adopted from the local restaurant. The markers are specifically revised into 6 different categories, which are Nasi (Nasi Goreng Ayam), Mee (Mee Rebus), Sup (Sup Ayam), Tomyam (Tomyam Ayam), Minuman (Kopi Panas), and Sayur (Kailan Ikan Masin). These categories are derived from the most common pick among customers, i.e., Rice, noodles, Soup, Tomyam, Beverage, and Vegetable.

Meanwhile, 3D Models of each marker were imported in Autodesk Maya, where the models were edited, scaled, and moved. All of these 3D models were then integrated into Vuforia and Unity to perform the AR contents for MenAR. After the tracker images are uploaded to the Vuforia website, a unity package is developed and imported into Unity Software; Vuforia produces its pattern. The Unity bundle contained these 3D models, which were then used to display AR content for MenAR.

A questionnaire-based study was conducted to assess user approval of the MenAR. The questionnaire was adopted by Saprikis et al. before being revised for the data collection. The study's key constructs were measured with 15 items on a five-Likert scale in between 1 = 'strongly agree' to 5 = 'strongly disagree,' namely PE (3 items), EE (3 items), SI (3 items), FC (3 items), and BI (3 items). All measurement items were developed from previous studies on information technology adoption by users. Data collection was carried out in the local restaurant, Restoran Kak Nah, located in Gong Badak, Terengganu, where at least 15 respondents among the customers were involved in the pilot study. MenAR app was installed as a .apk file in the smartphone prepared before the fieldwork. The customers who were chosen as the respondents were instructed to complete the questionnaire upon using the MenAR app.

As shown in Figure 2, MenAR was created in this study using a marker-based technique. A traditional menu was used as a physical marker to create Augmented Reality content. It is an interactive menu in that it can be interacted with using the MenAR program. MenAR users can use this MenAR application to explore AR content by using the mobile phone and scanning the marker 2D image in the standard menu.

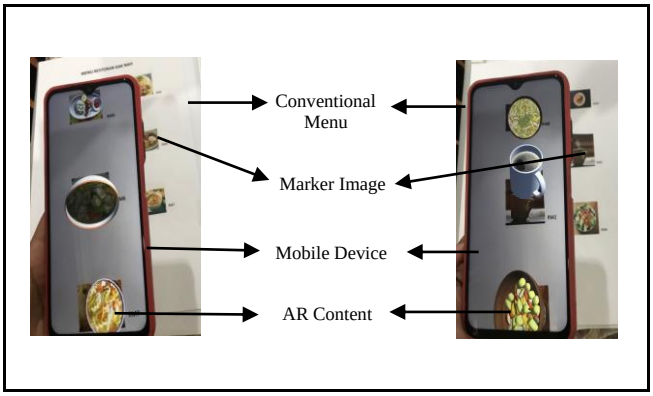

Fig. 2 AR installation – AR content for MenAR

4. Analysis and Results

This study focuses on a few main aspects as moderators among the diners chosen as respondents who inquired about testing the Men AR app and completing the questionnaire afterward.

Table 1. Frequency of Respondents' Age and Gender

	Age		Gender	
	15-24	**25-64**	**Male**	**Female**
Frequency	5	10	7	8

According to Table 1, the total number of respondents involved is 15, with ages divided into two categories (15-24) and (25-64). The frequency table shows that 5 among the first age category (15-24) while 10 respondents are from the second age category (25-64). Apart from that, another factor being considered is the gender of Male and females. 7 male respondents partake in this study, while another 8 respondents were female.

Table 2. Frequency of Respondents' Experience

	Smartphone User		Stable Internet Access		Familiar of AR	
	Yes	**No**	**Yes**	**No**	**Yes**	**No**
Frequency	15	0	14	1	13	2

In Table 2, three main determinants for respondents' experience are recognized to understand how these factors may insist on smoothness while completing the questionnaire. The first experience being considered in this study was whether or not the respondents were smartphone users. The second experience was whether or not the respondents had stable internet access, and the last one was to determine whether or not the respondents were familiar with AR technology. The analysis result has shown that all respondents are smartphone users while one of them does not have stable internet access, and two of them are not familiar with AR technology.

Table 3. Coefficients of Multiple Regression

Independent Variable	Dependent Variable	*p*	β
BI	**PE**	0.000	0.565
	EE	0.001	0.087
	SI	0.021	0.249
	FC	0.002	0.278
$\mathbf{R^2}$			0.824

The findings of the multiple regression analysis show that a Behavioural Intention (BI) regression model based on Social Influence (SI), Facilitating Conditions (FC), Performance Expectancy (PE), and Effort Expectancy (EE) has formed R-square (R2 = 0.824) suggesting that the change in the independent variables may explain 82.4 percent of the variation in the dependent variables. Hence, the correlation between users' behavioral intention to use MenAR and all the other four dependent variables is high as it came out above 50 percent. According to the findings, all four variables, PE, EE, SI, and FC, had a beneficial impact on users' intention to use the technology. PE (β = 0.565), which is higher than EE (β = 0.087), FC (β = 0.278) and SI (β = 0.249) when comparing these three factors, has a greater impact on consumers' acceptability of utilising this application. This shows that MenAR is a reliable application for restaurant menu items, with Performance Expectancy becoming the most influential factor for users' acceptance of this technology

5. Discussion and Conclusion

The current study explores the factors that influence consumers' acceptance of augmented reality (AR) using the MenAR application as an experiment instrument. Based on the necessity of this study, the UTAUT model was chosen to achieve this key goal. This research suggests that the UTAUT model is a valuable foundation for better understanding the food ordering process and how users utilize MenAR to use augmented reality.

As the result of this study has shown, many previous studies had found that PE has a considerable influence on the BI of suggested technology, as evidenced by [11,25,13,4,27]. Since MenAR's content focuses on food ordering operations, most clients concentrate on the application's Performance Expectancy (PE).

Using the UTAUT model, the data in this study's multiple regression analysis revealed that PE is the primary contributor to users' acceptance of MenAR. According to the studies, MenAR is simple to use and does not necessitate a lot of cognitive loads to grasp. It could be linked to the constant availability of technology due to the growth of AR technology, which can be simply implemented for food ordering with the presence of QR Code technology for menu item selection.

As this study embarks upon the AR application for food ordering systems, MenAR was thoroughly developed to create a more interactive and immersive menu item selection for the restaurant's customers. Aside from that, the UTAUT model was applied in this study to gauge MenAR as one of the latest advancements in the meal ordering system. Furthermore, as for the upcoming works, the study should be expanded and vary into different areas of the food ordering system aside from the restaurant's menu item, where the sample size should be set to be larger than the current one.

Acknowledgments

The author would like to acknowledge the Center for Research Excellence and Incubation Management (CREIM), Universiti Sultan Zainal Abidin.

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