The Design of Souvenir Products Presented through Augmented Reality for the King Naresuan Exhibition and Convention Center

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Abstract

The purposes of this research were 1) to study and analyze souvenir products for the King Naresuan Exhibition and Convention Center, 2) to design those souvenir products presented through augmented reality (AR) technology, and 3) to assess consumer satisfaction with the design of those souvenir products presented through AR technology. The study was conducted in two phases. In Phase 1, the researchers collected preliminary data by reviewing documents, theories, and research related to the design of souvenir product identities and visiting museums in Phitsanulok and Bangkok to create a questionnaire for use in assessing the needs identified by the research sample group. The data that were obtained were used for designing and creating the sketches of souvenir products, including the designed cartoon characters (a total of 40 patterns). These sketches were assessed using an assessment form and chosen by the experts in the field of souvenir product design. The chosen sketches were then used as prototypes for actual production in the next phase. In Phase 2, the five selected cartoon characters were used to produce the prototypes of souvenir products that could be presented through AR technology. The user could use his/her smart devices (e.g., a phone or a tablet) that had the NUsouvenirs application installed, to scan the souvenir products. The story and history of the King Naresuan Exhibition and Convention Center were presented. The souvenir products' design as presented through AR technology was then assessed by the experts in the field of AR design and by the research sample group. The results showed that the design of the products, and the satisfaction with this AR experience and this AR application, were suitable for use in terms of uniqueness, design, usability, and suitability for being sold in stores. The AR technology was shown to be effective in promoting visitor involvement by purchasing souvenir products and gaining AR experience. Suggestions gained from the study and suggestions for further research are also discussed.

Keywords: Augmented reality, Souvenir Products, King Naresuan Exhibition and Convention Center, Phitsanulok Province

Introduction

Computer digital technology is being used to develop industries and economies worldwide, and its impact on creating added value in both services and product development is significant. Marketing products is a highly competitive industry in advertising, public relations, and creating distinctive features for individual products to increase sales (Agag et al., 2024). The souvenir product is one of the artistic and cultural products that shows the identity of the local area, so these products must be creatively designed to continue to evoke fond memories and images, adding value to them (Department of Industrial Promotion, 2016).

To make creative souvenir products, it is crucial to combine cultural wisdom and the use of modern technology since this can create a new impression for consumers. Using modern technology is an important way to create impressive souvenir products to support the creative economy policy following the guidelines of the National

Development Strategy in the National Economic and Social Development Plan No. 13 (2023-2027), intending to transform Thailand to keep pace and be in line with changes of the world. In addition, it aims to create balance in the fair distribution of benefits from development to all economic and social sectors. Also, it enhances the quality of life and maintains the sustainability of natural resources and the environment, elevating Thailand to be a country where "the economy creates value and the society moves forward sustainably" (Ministry of Social Development and Human Security, 2022).

Thailand is a tourism destination that emphasizes value and sustainability. This is in line with the National Economic and Social Development Plan No. 10 which places importance on building the stability of the community economy and strengthening the community to encourage the community to use knowledge from artistic and cultural heritage. This aims to create, develop, and expand quality cultural products appropriate to the uniqueness of each community. This notion follows the development strategy of Phitsanulok Province that focuses on developing the creative economy, being an innovative city based on technology and innovation, raising the standard of tourism and service products, preserving tradition and culture, and being a city of learning (Phitsanulok Province, 2020).

During 2020-2021, the Tourism Authority of Thailand conducted a study on the travel behavior of 30,800 Thai tourists in secondary cities. It was found that the three most popular secondary cities to which tourists liked to travel were Chiang Rai, Nakhon Si Thammarat, and Phitsanulok. Interestingly, in Phitsanulok Province, the satisfaction level of tourists was rated as 4.78 out of 5 which is considered as a very high level. Additionally, based on the study, most tourists travel by private car and prefer to travel to temples, national parks, and folk museums in Phitsanulok Province (Tourism Authority of Thailand, 2021).

Promoting tourism in preserving traditions and culture and learning aspects of Phitsanulok Province requires the many places that are open for visiting, such as historical sites, folk museums, and history museums. The King Naresuan Exhibition and Convention Center at Naresuan University, which opened in 2022, is one of the most interesting places to visit in Phitsanulok Province and is used as an international exhibition and conference center for the general public and tourists to visit. The Convention Center's purpose includes the recognition and honoring of the great and courageous warrior king, King Naresuan, who helped restore Thailand's freedom and maintained the prosperity of the country, including economy, society, arts and culture, enabling the preservation of national independence until the present. The Convention Center also commemorates important historical events in the role of a museum that is a source of learning about the history of Phitsanulok Province and the lower northern region. Currently, however, it lacks advertising and souvenir products to sell to visitors in shops. Souvenirs reflect the uniqueness of the museum and create a lasting impression for the visitor of their new experience.

Smartphones are considered the 5th factor in the lives of consumers, enabling their behavior in the digital age. The use of modern devices and technology has expanded widely among users of all genders and ages. The use of modern technology of Augmented Reality (AR) technology in conjunction with electronic devices and smartphones plays an important role and is widely applied to various fields, such as the fields of art, medicine, commerce, and education (Tarafdar et al., 2024). AR technology is a technology that combines the real world with the virtual world through joint hardware devices with the use of various software. This creates images that can be seen and

looks like objects (National Science Museum, 2021). They will be displayed on the image screen of both two-dimensional (2D) and three-dimensional (3D) objects, making it possible to see the objects floating above real surfaces, or there is an impression that the movement looks exciting. This AR technology can be combined to create a new form of souvenir product presentation to make it interesting and unique. Also, the history of souvenir products can truly create excitement in the form of interactive media (Purnomo et al., 2018).

The researchers were therefore interested in creating a new identity for souvenir products by inserting historical stories of King Naresuan the Great. Tourists can buy souvenir products to use or take them away as reminders of their visit to Phitsanulok Province. In this research, in addition to studying the process of designing souvenir products to create added value for the museum, historical stories were created for use in AR technology to give buyers a new experience in purchasing souvenirs. The researchers hope that the findings of this study will be useful to the relevant agencies and can be used as a guideline for future research for the most benefit.

Research Objectives

1. To study and analyze souvenir products for the King Naresuan Exhibition and Convention Center
2. To design souvenir products presented through augmented reality (AR) technology for the King Naresuan Exhibition and Convention Center
3. To assess consumer satisfaction with the design of souvenir products presented through AR technology for the King Naresuan Exhibition and Convention Center

Augmented reality (AR) technology is a technology that employs a camera in a computer or smart devices such as mobile phones and tablets. They are used to display graphics or objects created by computer programs, and they are presented in various forms; video, sound, or 3D models overlaying the real environment. This aims to create a more realistic experience for users. The user can interact between digital objects and the environment as they appear on the screen of the electronic device (Tarafdar et al., 2024). There are, however, some technical and visual limitations (e.g., small eyeboxes and limited brightness) as noted in Cooper (2023). Liang (2015) proposed the Architecture of Augmented Reality and its six different components: user, interaction, device, virtual content, tracking, and real-world entity. The working process shown in Fig. 1 demonstrates the usage pattern through electronic devices that are processed through the tracking system and presented with images created by computer programs. These can be still images, animations, or 3D models combined with the real environment.

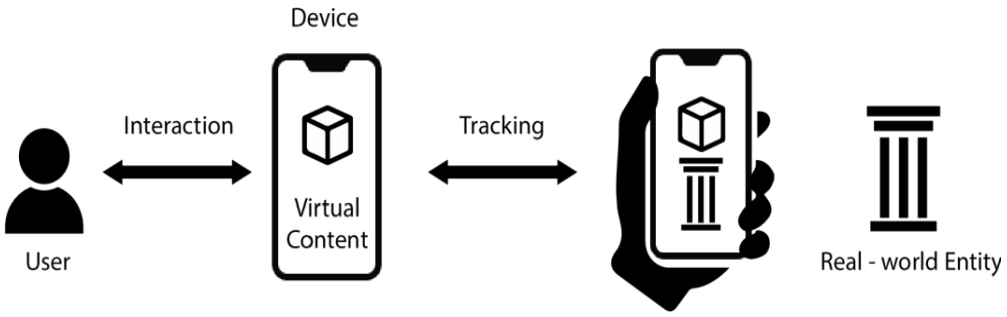

Figure 1 Augmented reality architecture, adapted from Liang (2015)

AR technology is being used in many different ways, such as in marketing, education, and tourism. Also, it is used in educational institutions and museums. Particularly in museums, this technology has been used as a component in providing information and creating attractions for users (Jin et al., 2024). According to Ghandour et al. (2021), the use of AR technology in conjunction with mobile phones can promote and organize travel activities for tourism businesses. It helps to arouse the interest of customers, especially in the historical and cultural context of the tour.

Wu et al. (2023) conducted a research study on AR marketing to encourage and enhance visits to a museum. They showed that using AR technology can increase the satisfaction of visitors who are generally open-minded to new technology and ready to learn even more. In addition, it is suggested the use of 3D in the presentation should be promoted as a way to increase visitor interest. Similarly, Bird et al. (2023) studied using head-mounted AR in a museum context to promote tourism, and the findings showed that the users who were involved in the tour gained AR experience, and were satisfied with this AR experience.

In addition, Apte et al. (2021) investigated the use of AR to enhance visitors′ interactions with the virtual content excitingly, aiming to use AR to aid learning and give positive museum experiences through smartphones. The study shows how to use web-based AR to allow the users to use their phone camera to entertain and learn by watching artefacts of the museum virtually. Importantly, qualitative results indicate that using AR technology benefits the learning of these users.

Yan et al. (2023) discussed the application of AR technology based on virtualization in the design of a digital museum, integrating digital media art with AR to enhance the user′s understanding of the real world, focussing on optimizing the organizational retaliatory behavior (ORB) algorithm based on the characteristics of the ORB algorithm. This algorithm calculates the orientation of the feature points and then constructs the feature descriptor. The result shows that it improves recognition accuracy by 16% which is higher than the traditional ORB algorithm. It can be concluded that this application of AR technology is crucial in digital media design.

Forster (2018) examined the potential of using AR technology to enhance interaction with photographic material in museums and archives, exploring how AR can enhance understanding of photographs and addressing the implications and limitations of this technology. The study indicates that AR is an ideal immersive technology for storytelling with photographic collections, and it can enhance engagement with collection materials and complement the viewing experience.

Purnomo et al. (2018) conducted a study on the implementation of AR technology in the Sangiran Museum using Vuforia as a guide to visitors to the museum. An AR application was developed that displays virtual information from ancient objects on display in text, audio, and 3D animations. The study focuses on the 3D markerless recognition process using the Vuforia AR system for viewing the exhibition objects through different viewpoints which are accessed by the visitors. The study showed positive results with the 3D markerless keypoint feature able to be detected from different viewpoints.

Jondya et al. (2022) investigated the development of an AR mobile application to provide complete information on historical war weapons for the Fatahillah Museum. This application allows visitors to view the weapons and

artefacts through 3D models. This was a successful development of a mobile application with AR technology using the Agile method. This application allows the users to have a good experience since the weapons and artefacts can be seen close up through a 3D model. Importantly, it reduces the risk of the damage or loss of historical objects by being virtual and the objects are not handled manually. Based on the evaluation results, the users were very satisfied with this application.

Methods and Materials

This section starts with the participants of the current study. The research instruments, data collection procedure, and the design of the souvenir products are then discussed. Finally, data analysis of the study results will be discussed. It should be noted that this study was conducted in two phases, and the details of each phase will be discussed in this section.

1. Participants

The participants in this research were divided into many groups since there were two phases of the study.

Phase 1: Studying related documents and research and sketching souvenir product designs

In this phase, the researchers divided the participants into three groups as follows.

Group 1: A group of 100 staff and students at Naresuan University who were interested in designing souvenir product identities for the King Naresuan Exhibition and Convention Center in Phitsanulok province. They were both males and females between the ages of 18 - 60 years or older resident in Phitsanulok province. The goal of this group was to elicit information about the personal information of respondents and their opinions about the identities of the souvenir products, and the factors affecting the design of those products, developing design guidelines simultaneously. Ethical reviews, permissions and approval were given by the Institutional Review Board (IRB), (IRB No. P2-0386/2564). At every stage, the participants' names remained confidential, and the results of this study will be used for academic purposes only.

Group 2: A group of 3 product design experts checked the design sketches before using them in actual production in the next phase. The criteria for selecting these experts were that, firstly, they were teachers or had academic experience in product design or other related fields. Next, they must be full-time lecturers teaching in tertiary education and have worked in the field of education or academic work for at least five years. Finally, they had to have completed at least a Master's degree.

Phase 2: Designing and producing prototypes using augmented reality (AR) technology and assessing the satisfaction of the souvenir products

In this phase, the researchers divided the participants into two groups as follows.

Group 3: comprised a group of 3 experts in AR design. After the researchers received data from the product designers in the first phase, the researchers used these data to design and develop actual prototypes to be presented through AR technology. Also, these prototypes were assessed in terms of the satisfaction from the three experts before seeking feedback on the satisfaction with the prototypes from the research sample group. The criteria for selecting these

experts were that, firstly, they were teachers or had academic experience in designing AR technology, animation, or other related fields. Also, they must be full-time lecturers teaching in tertiary education and have worked in the field of education or academic work for at least five years. Finally, they had to have completed at least a Master's degree.

Group 4: Comprised of a group of 100 staff and students at Naresuan University, both males and females between the ages of 18 - 60 years and older, resident in Phitsanulok province. They were asked to assess their satisfaction with souvenir products that were presented through AR technology for the King Naresuan Exhibition and Convention Center.

2. Research Instruments

Four sets of research instruments were used to collect data:

1. A questionnaire regarding needs and attitudes about souvenir products. The researchers asked the research sample group about general personal information and their opinions about the identity and the factors affecting the design of souvenir product identities.

2. An assessment form for the experts regarding the sketches of souvenir product identity design for the King Naresuan Exhibition and Convention Center.

3. An assessment form for the experts regarding their opinions on the design of AR technology.

4. A questionnaire for a research sample group regarding their satisfaction with the souvenir product design for the King Naresuan Exhibition and Convention Center.

3. Data Collection Procedure

As mentioned earlier, the study was divided into two phases, so the details of data collection of each phase will be discussed separately.

Phase 1: Studying related documents and research and designing the sketches of souvenir products

As for Phase 1, the researchers collected data from reviewing literature, theories, and research related to the design of souvenir product identities. To do this, a structured synthesis of the literature review and research related to the issue of souvenir product identity design criteria was conducted. The criteria for the souvenir product design contests of 10 selected projects were synthesized and employed. These 10 projects were as follows.

1) The Design of Souvenir Products That Convey the Identity of Art, Culture, and Local Wisdom of Surin Province in 2019

2) The Contest for Prototype Souvenir Products from Antiques and Objects of the World Heritage City of Ayutthaya in 2017

3) The Product / Souvenir Products Design Contest at Prince of Songkla University Phuket Campus in 2021

4) Nakhon Sawan Province Souvenir Product Design Contest in 2018

5) The Souvenir Design Contest from Natural Materials of Chiang Mai Night Safari in 2019

6) The Souvenir Design Contest "Swag Contest" under the "FRIENDS" project in 2019

7) The Contest for Designing Innovative Souvenir Products for Tourism from the Intellectual Property of the Tourism Authority of Thailand (TAT) in 2020

8) Rayong Provincial Souvenir Contest in 2019

9) The Souvenir Prototype Contest: The Art of the Kratua Thaeng Sua (Thai Traditional Martial Play) under the hackathon activity (U2T Hackathon 2021)

10) Southern Souvenir Contest 2019

The criteria for designing souvenir products, derived from these 10 projects, consisted of 1) creativity, 2) beauty, 3) modernity, 4) usability, 5) having a market opportunity and being able to be produced commercially, 6) conveying the organization's identity, 7) notability, 8) utility, and 9) interpreting the meaning of the work. Additionally, these criteria were also used to generate the questionnaires and the assessment forms in this study. The researchers also visited and observed souvenir shops at museums in Phitsanulok province and Bangkok to find design guidelines. Applying these design guidelines, the researchers synthesized the data to create 1) a questionnaire regarding needs and attitudes about souvenir products, 2) an assessment form for the experts regarding the sketches of souvenir product identity design, 3) an assessment form for the experts regarding their opinions on the design of AR technology, and 4) a questionnaire for a research sample group regarding their satisfaction with the souvenir product design for the King Naresuan Exhibition and Convention Center. Before collecting the data, the questionnaires and the assessment forms were checked for the index of item-objective congruence (IOC), and the IOC scores reached a high-level value of 0.95.

The questionnaire regarding needs and attitudes about souvenir products was then used to collect data with the research sample of 100 people. The data obtained from the research sample group were used to design souvenir product sketches. These sketches were then assessed for satisfaction and recommendations from product design experts. Also, these sketches were chosen for the design of prototypes for actual production in Phase 2.

Phase 2: Designing and producing prototypes using augmented reality (AR) technology and assessing the satisfaction of the souvenir products

After obtaining the results from Phase 1 and the chosen sketches of the souvenir product design, the researchers used them to design and produce the prototypes of souvenir products that could be presented through AR technology for the King Naresuan Exhibition and Convention Center. The criteria for designing AR technology included 1) interestingness, 2) creativity, 3) content and language use, 4) images, fonts, and presentation techniques, and 5) the overall AR technology. The souvenir products using AR technology were then assessed by three experts in the design of AR technology and their satisfaction with the prototypes was used to accept and improve them before assessing the satisfaction with a research sample group of 100 people as the final step for summarizing and evaluating further.

4. The Design of the Souvenir Products

To look in great detail at the design of the souvenir products in Phases 1 and 2, in this process, two steps followed:

Step 1: Creating the sketches of the souvenir products

After obtaining design requirements and guidelines, the researchers created the sketches of seven souvenir products, five patterns per product, consisting of 1) pillows, 2) shirts, 3) bags, 4) dolls, 5) eye masks, 6) cloth masks, and 7) refrigerator magnets as shown in Figure 2 below. In this process, the graphics and identities obtained from the study were used to first create 40 cartoon characters suitable for the King Naresuan Exhibition and Convention Center. Then, five cartoon characters were selected by the experts. The design of the prototypes of the seven souvenir products with five patterns per product is shown in the figure below.

Step 2: Using AR technology to present historical stories and background

After finishing Phase 1, the researchers brought the selected cartoon characters to produce the prototypes of souvenir products that could be presented through AR technology. It was conducted by creating three-dimensional (3D) models of these five cartoon characters. These were used with seven types of souvenir products, as shown in Fig. 2, so that they would present their history stories and background. Each character had a different history through AR technology. The researchers used the MAYA program to create 3D animated cartoon characters. The researchers then used Unity and Vuforia programs to create AR technology. The process of designing and creating 3D animations presented through AR technology is shown in Fig. 3 below. The researchers used all five cartoon characters that were designed according to the research results in Phase 1, and they were printed with a printing system that provided high-resolution image colors on materials with smooth surfaces such as paper, cloth, or smooth surface materials so that these surfaces could be used by electronic devices, phones, or tablets in the Android system to scan images through souvenir products. Then, the users could see 3D animations that presented the story and history of the King Naresuan Exhibition and Convention Center as shown in Fig. 4-5 in the Result and Discussion section.

For the design of AR technology design for the King Naresuan Exhibition and Convention Centre, the researchers designed the products to be different in terms of patterns, concepts, creation, animations, and audio narration which resulted from the literature review and research related to the criteria for AR technology design that were used as guidelines for designing AR technology, including the results of collecting the data regarding the design of AR for the King Naresuan Exhibition and Convention Center. The design was inspired by the history, traditions, and culture of the local area regarding the legend of King Naresuan the Great. As for using AR technology, the user scanned a QR code to download the NUsouvenirs Application onto a phone or tablet in the Android system. A 3D cartoon character would appear, and it would be able to move, speak, and explain the concept and history in which each character played a different history.

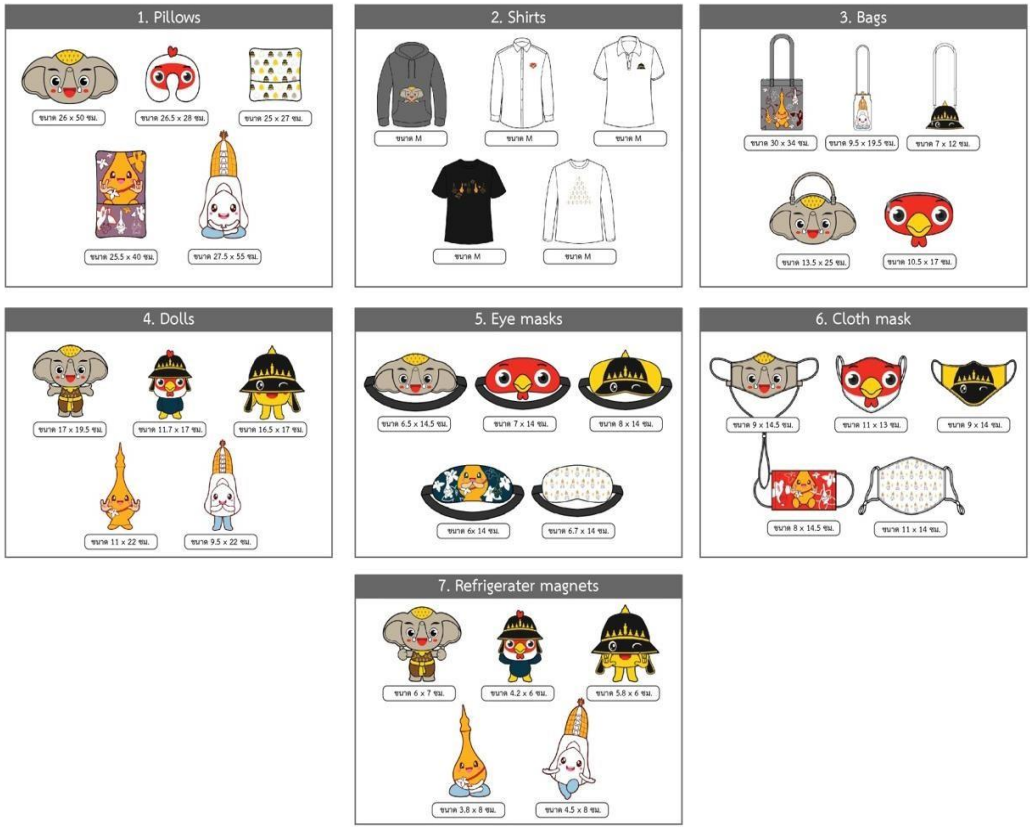

Figure 2 The design of the prototypes of the seven souvenir products with five patterns per product

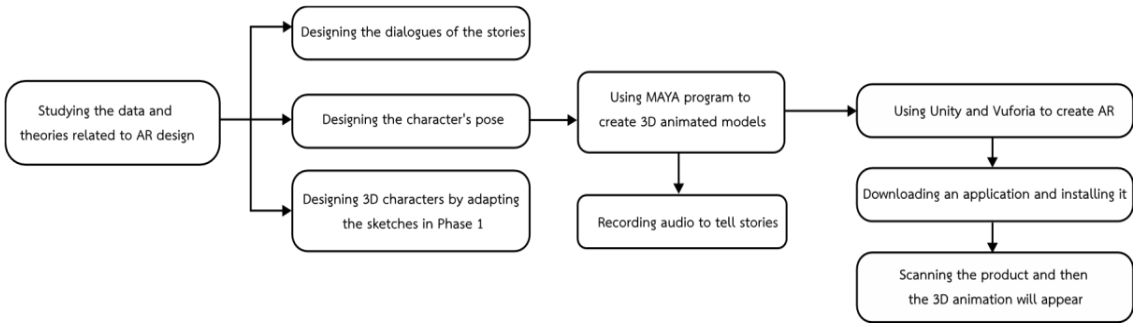

Figure 3 The process of designing and creating 3D animations presented through AR technology

5. Data Analysis

In this research, data analysis was also divided into two phases according to the different phases of the study. For Phase 1, the data were knowledge gained from studying related documents, theories, and research studies concerning the design of souvenir product identities. The obtained data were analyzed by using content analysis. After that, the questionnaire regarding needs and attitudes about souvenir products and the identities and the factors affecting the design of souvenir product identities and the assessment form for the experts regarding the sketches of souvenir product identity design for the King Naresuan Exhibition and Convention Center were

employed to collect data. The obtained data were then analyzed by using frequency, mean, standard deviation, and content analysis.

As for Phase 2, the data were obtained from the assessment form for the experts regarding their opinions on the design of AR technology. A list of assessments included 1) having an appropriate size and beautiful colors, 2) being convenient and easy to use, 3) being accurate, compact, and clear, 4) being easy to understand, 5) being suitable in terms of the movement of images, models, and information, 6) being modern, and 7) attracting attention.

Additionally, after obtaining the results from the experts' assessment, the researchers developed the design of the souvenir products. Then, the souvenir products (five sets in total) were assessed in terms of consumer satisfaction with the design of souvenir product identities with cartoon characters through AR technology for the King Naresuan Exhibition and Convention Center with a sample of 100 people, as shown in Table 1, with the below list of assessment. These data were then analyzed by using frequency, mean, standard deviation, and content analysis.

Souvenir products

1) Uniqueness/identity

2) Beauty

3) Having appropriate patterns and design

4) Having appropriate usability

5) Being convenient to use

6) Being strong and safe to use

7) Being suitable to be sold in stores

8) Additional suggestions for designing souvenir product identities with cartoon characters through AR technology for the King Naresuan Exhibition and Convention Center

AR technology 3D models

1) Being convenient and easy to use

2) Having a beautiful design

3) Being clear, interesting, thought-provoking, and worth following

4) Being appropriate in displaying images and information

5) Being able to be used to promote sales and tourism

6) Additional suggestions for designing souvenir product identities with cartoon characters through AR technology for the King Naresuan Exhibition and Convention Center

Results

The results of this research are presented according to the three research objectives of this study.

Regarding Research Objective 1 aiming at studying and analyzing souvenir products for the King Naresuan Exhibition and Convention Center, after the synthesis, the researchers found that there were crucial aspects that needed to be used as guidelines for designing the identity of souvenir products. The main principles in designing souvenir product identities were 1) originality, 2) having market opportunities, 3) communicating the uniqueness/identity of the organization, 4) beauty, and 5) the distinctiveness and interest of the product. In addition to the criteria that were synthesized to fit the context of the souvenir product identity design in this study, the researcher therefore added one more aspect which was the suitability to sell in stores at the King Naresuan Exhibition and Convention Center.

As for Research Objective 2 aiming at designing souvenir products presented through AR technology for the King Naresuan Exhibition and Convention Center, based on the results obtained from Phase 1, the researchers designed and created a total of 40 3D cartoon characters, and five characters were selected, including 1) Phlai Phu Khao Thong, 2) Yellow White-tail Fighting Cock, 3) Phra Mala Biang, 4) Phra Tao Thaksinothok, and 5) Phra Prang (Mamee & Chuenchaichon, 2024), as shown in Fig. 4 below.

Figure 4 Five 3D cartoon characters for the King Naresuan Exhibition and Convention Center

As for using AR technology, the user scanned a QR code to download the NUsouvenirs Application onto a phone or tablet in the Android system. A 3D cartoon character would appear, and it would be able to move, speak, and explain the concept and history in which each character had a different history as shown in Fig. 5 below.

Figure 5 Using AR technology to present the story and history of the King Naresuan Exhibition and Convention Center through the souvenir products

Fig. 6 shows the images of the actual souvenir products that were produced, including seven souvenir products with five patterns, as presented in the initial sketches. The researchers divided them into five sets of souvenir products according to the chosen cartoon characters that were designed to be suitable for the King Naresuan Exhibition and Convention Center. With these five sets, the buyer can scan the purchased product to view 3D animation that tells the story and history of the King Naresuan Exhibition and Convention Center.

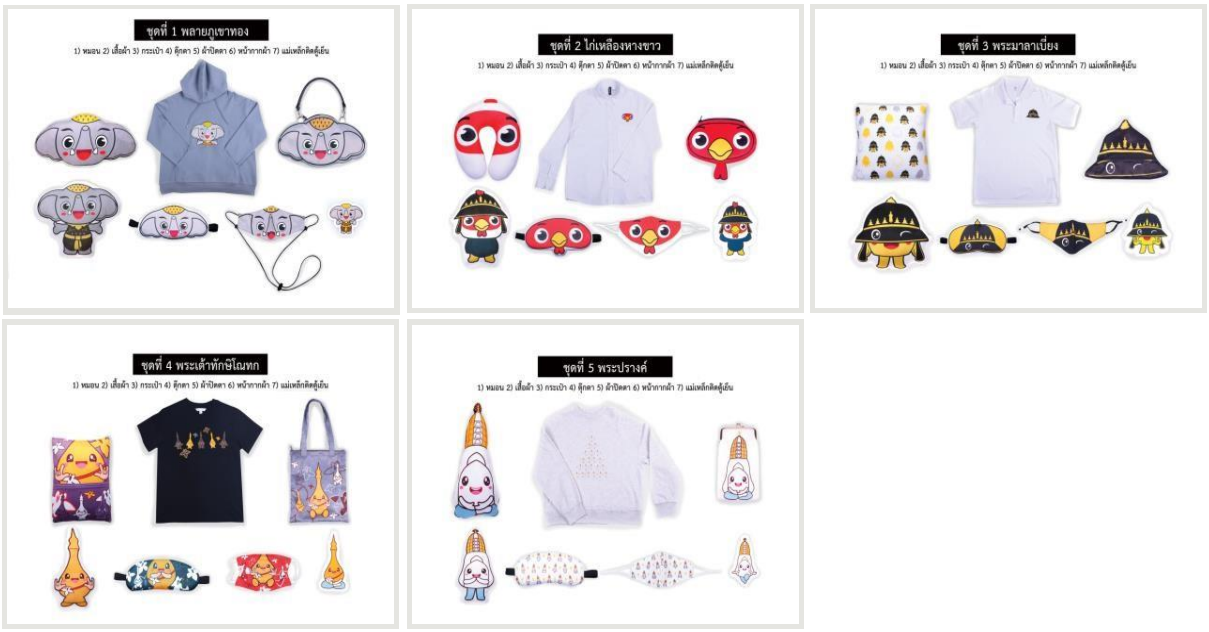

Figure 6 Actual souvenir products

Research Objective 3 was aimed at assessing consumer satisfaction with the design of souvenir products presented through AR technology for the King Naresuan Exhibition and Convention Center. Regarding the

assessment results from the experts, it was found that 1) the AR technology 3D models had appropriate size and beautiful colors ($\bar{X}$ = 4.67, S.D.=0.58), 2) they were convenient and easy to use ($\bar{X}$ =4.33, S.D.=0.58), 3) they were accurate, compact, clear ($\bar{X}$ =4.67, S.D.=0.58), 4) they were easy to understand ($\bar{X}$ =5.00, S.D.=0.00), 5) they were suitable in terms of the movement of images, models, and information ($\bar{X}$ = 4.67, S.D.=0.58), 6) they were modern ($\bar{X}$ =5.00, S.D.=0.00), and 7) they could attract attention ($\bar{X}$ =4.67, S.D.=0.58). Regarding every aspect, it was appropriate at the highest level ($\bar{X}$ =4.72, S.D.=0.41). Furthermore, experts made some suggestions that when scanning through electronic devices, the size of 3D cartoon characters should be larger so that they could add more interest. In addition, the movement of cartoon characters was limited by their shape, so their movement was limited, and could not act as much as they should.

In terms of the customer satisfaction assessment, the results are shown in Table 1 below.

Table 1 The results of the analysis of customer satisfaction with the design of souvenir products presented through AR technology for the King Naresuan Exhibition and Convention Center (N =100)

Souvenir Products and a list of assessment	$\bar{X}$	**S.D.**
Souvenir Product Set 1: Phlai Phu Khao Thong		
1. Uniqueness/identity	4.21	0.69
2. Beauty	4.14	0.75
3. Having appropriate patterns and design	4.19	0.80
4. Having appropriate usability	4.19	0.87
Souvenir Products and a list of assessment	$\bar{X}$	**S.D.**
5. Being convenient to use	4.09	0.90
6. Being strong and safe to use	4.21	0.77
7. Being suitable to be sold in stores	4.17	0.84
Total	4.17	0.80
Souvenir Product Set 2: Yellow White-tail Fighting Cock		
1. Uniqueness/identity	4.30	0.95
2. Beauty	4.29	0.89
3. Having appropriate patterns and design	4.22	0.89
4. Having appropriate usability	4.21	0.76
5. Being convenient to use	4.21	0.76
6. Being strong and safe to use	4.29	0.84
7. Being suitable to be sold in stores	4.21	0.81
Total	4.25	0.84

Table 1 (Cont.)

Souvenir Product Set 3: Phra Mala Biang		
1. Uniqueness/identity	4.38	0.79
2. Beauty	4.06	0.81
3. Having appropriate patterns and design	4.12	0.81
4. Having appropriate usability	4.18	0.87
5. Being convenient to use	4.15	0.88
6. Being strong and safe to use	4.36	0.87
7. Being suitable to be sold in stores	4.36	0.88
Total	4.23	0.84
Souvenir Product Set 4: Phra Tao Thaksinothok		
1. Uniqueness/identity	3.92	0.98
2. Beauty	4.17	1.00
3. Having appropriate patterns and design	4.27	1.01
4. Having appropriate usability	4.40	0.93
5. Being convenient to use	4.44	0.94
6. Being strong and safe to use	4.33	0.84
7. Being suitable to be sold in stores	4.41	0.93
Total	4.28	0.95
Souvenir Product Set 5: Phra Prang		
1. Uniqueness/identity	3.76	0.92
2. Beauty	4.00	0.93
3. Having appropriate patterns and design	4.03	0.96
4. Having appropriate usability	4.14	0.90
5. Being convenient to use	4.13	0.98
6. Being strong and safe to use	4.29	0.98
7. Being suitable to be sold in stores	4.08	0.93
Total	4.06	0.94
AR technology 3D models		
1. Being convenient and easy to use	4.48	0.75
2. Having a beautiful design	4.69	0.65
Souvenir Products and a list of assessment	$\bar{X}$	**S.D.**
3. Being clear, interesting, thought-provoking, and worth following	4.45	0.69
4. Being appropriate in displaying images and information	4.38	0.68
5. Being able to be used to promote sales and tourism	4.68	0.63
Total	4.54	0.68

Source: Mamee and Chuenchaichon (2024)

As Table 1 shows, the Souvenir Product Set 3 (Phra Tao Thaksinothok) obtained the highest satisfaction from the customers ($\bar{X}$=4.28, S.D.=0.95). It was followed by the Souvenir Product Set 2 (Yellow White-tail Fighting Cock) ($\bar{X}$=4.25, S.D.=0.84), the Souvenir Product Set 4 (Phra Mala Biang) ($\bar{X}$=4.23, S.D.=0.84), the Souvenir Product Set 1 ($\bar{X}$=4.17, S.D.=0.80), and the Souvenir Product Set 5 ($\bar{X}$=4.06, S.D.=0.94). Overall, the satisfaction with all five souvenir product sets was at a high level. Particularly, the uniqueness/identity and being strong and safe to use of almost all product sets showed high satisfaction in a list of assessments. Additionally, the satisfaction with AR technology 3D models, the overall result was at the highest level ($\bar{X}$=4.54, S.D.=0.68). When considering each aspect of the assessment, it also revealed the highest level of satisfaction, particularly in the aspects of having a beautiful design ($\bar{X}$=4.69, S.D.=0.65) and being able to be used to promote sales and tourism ($\bar{X}$=4.68, S.D.=0.63). To conclude, this indicates that the design of souvenir product identities with cartoon characters through AR technology for the King Naresuan Exhibition and Convention Center was good and met the customers' needs, expectations, and satisfaction.

Discussion

The results obtained from this study show that AR technology can encourage visitors to become involved in purchasing souvenir products and gaining AR experience, and 3D cartoon characters play a crucial role in the design of souvenir products. As shown in Mamee and Chuenchaichon (2024), the designed products were unique, cute, collectable, and exotic because they used Thai cartoon characters in the design. Also, they were useful and suitable for souvenirs. This is consistent with the study conducted by Jongsriratanakul (2017) who found that cartoon characters add value to the brand or products, and they make the brand or the product look more valuable, special, and different from other competitors in the market which reinforces the brand positioning.

This study revealed positive results for the use of AR technology in museums. These results support the study by Wu et al. (2023), Bird et al. (2023), and Forster (2018) who found that AR technology can enhance intention to visit the museum since the visitors are involved in the tour, gain AR experience, and felt satisfied with this experience. Also, the results are in line with those found in Purnomo et al. (2018) who use Vuforia as a guide to visitors in the museum, and it reveals the positive results since the visitors can watch the exhibition objects through different viewpoints. Also, the findings of this study go parallel with the findings of Jondya et al. (2022) who developed an AR mobile application to provide information on historical war weapons for the Fatahillah Museum. It allows visitors to view them through 3D models, and this application allows them to have a good experience because the object can be seen closely through a 3D model. Most importantly, the users were very satisfied with this AR application.

Conclusion and Suggestions

We studied the information about the design of souvenir product identities for the King Naresuan Exhibition and Convention Center and successfully designed and created souvenir products presented through augmented reality (AR) technology for the King Naresuan Exhibition and Convention Center. Satisfaction with this AR experience and application design in this present study were also assessed and proved that they were suitable for use. The results of this study showed that AR technology can encourage visitors to be involved in purchasing souvenir products and gaining AR experience. All age groups could use AR technology effectively without significant differences, indicating simplicity of use. Therefore, the use of AR technology in this study can be applied to other contexts, such as art galleries, learning centers, and libraries.

The suggestions of the study are as follows. First of all, the images used must be sharp and clear so that they can be easily scanned through the camera during the design process. Secondly, the surface of the materials must be smooth and not glossy so that the presentation of the images will be sharp and clear. Thirdly, the scanning areas should not be outdoors or in places with too much light or too little light since it will make scanning images difficult. Finally, the use of AR technology requires installing the application via mobile phone. If the user uses a program that does not require installing an application on his/her mobile phone, it will be more convenient to use.

For future research, it is suggested that, since NUsouvenirs Application in this present study supports only the Android system, the future study on the iPhone Operating System (IOS) system should be investigated. Additionally, a study on the use of applications that do not require an installation by the user, but the user can use AR features via Facebook or Instagram Applications instead to access all platforms, should be conducted. These suggestions indicate that the effectiveness, safety, and behavior of the users must be considered. Furthermore, the variety of age groups canvassed in the study, started from 20 years old. Exploring the use of AR technology for younger age groups, between 6 and 12 years old, for example, can be challenging for further research.

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Author Contributions

Author 1(Waraporn Mamee): Conceptualization of the research, Development and design of methodology, Data collection, Data analysis and interpretation

Author 2 (Chayanis Chuenchaichon): Development and design of methodology, Data analysis and interpretation, Manuscript writing, Manuscript review and editing, and Corresponding

Conflict of Interests

The authors declare no conflicts of interest.

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