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Improving the Spectator Experience of AR Sports Events from a Service Design Perspective – Using HADO as an Example

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Abstract: Augmented reality (AR) has been used to improve the spectator experience in traditional sports events. For the first AR sports in the world, Meleap's HADO, the discussion of spectator experience in watching AR sports is lacking. To understand the problems and flaws in the spectator experience of AR sports events, we have conducted a two-phase investigation into Meleap's HADO. The first phase investigated HADO's live sports events, while the second phase examined their online sports events. We used questionnaires and semi-structured interviews and conducted an integrated analysis based on the quantitative and qualitative results to determine how to optimize HADO's spectator experience. Finally, as a reference for future studies, we summarized the challenges and issues found in the spectator experience of AR sports.

Keywords: augmented reality; service design; user experience design; spectator experience

1. Introduction

The global industry is undergoing changes thanks to technological advancement; as watching sports events on mobile devices has become a trend, this continues to inspire more personalized, socialized and diverse solutions. Many companies in the sports industry have realized that spectators frequently change the way they watch the games, and in response have created many innovative solutions combining sports events with technology. During the 2018 World Cup, for example, many sports channels and online stream platforms supported Virtual Reality (VR) live streaming. Compared to VR, which requires heavier equipment, Augmented reality (AR) is more portable and can provide instant rendering, which translates into quality user experience.

User experience refers to a user's physical and psychological reactions, emotions, preferences, perceptions and behavior in his/her interaction with a service, product or

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company (Norman, Miller, & Henderson, 1995). AR brings brand new experience for the users, including new types of sports events and new spectator experience. Past case studies and research on spectator experience is based on watching traditional sports games. Since our research case is the world's first AR sports game, it brings not only a whole new game watching experience to spectators but also a new area to discuss. Through our in-depth case study, we hope that we will be able to gain an insight into the current problems and challenges of watching sports events with AR, and to propose suggestions on how to improve spectator experience. The results will serve as reference for future studies.

2. Literature review and related work

2.1 Augmented Reality and Its Applications to the Sports Industry

AR applications in sports industry are divided into two categories: watching and participating. In terms of watching, AR has been widely adopted in sports broadcasting. Ericsson, for instance, introduced Piero AR in 2016, which allowed broadcasters to overlay 3D graphics in real time during live studio productions and sports games. On the other hand, when it comes to participating in AR sports events, AR is integrated into traditional sports. Meleap (hereafter, the Company), a Japanese startup, combined AR with dodgeball and created HADO AR sports to expand the sports industry, making it the world's first AR sports game.

AR has changed the way people watch and participate in sports games; we are now officially in the "AR competitive sports era". In the past, AR was mostly used to improve the connection and interaction between the spectators and the events. However, there has not been enough discussion over the spectator experience when watching AR sports games, indicating that there are still challenges to overcome when it comes to AR sports games' spectator experience, which also requires innovation.

2.2 Service Design

In the competitive service industry, products alone can no longer satisfy the picky consumers (Pine & Gilmore, 1998). Similarly, sports lovers are also pursuing a type of unprecedented experience. Spectator sport is about the experience of an intangible product; fans long for the experience, which will in turn create wonderful memories for them. Each live broadcast of a ball game must show the fans that it is highly worth watching—otherwise, it will lose its spectator (Huei-Fu Lu, 2011).

Currently, academia and the industry have a wealth of discussion and research in service design, but there is no agreed-upon definition. Service design is a newly emerging design that adopts a holistic, multidisciplinary and integrative approach (Ho & Sung, 2014). It is even more comprehensive and involves understanding the users, their backgrounds, service providers and social practice, then transforming such insight into the interactive development of evidence and the service system. Service design is also considered an explorative process that is meant to create new valuable relationships among different

participants and develop and integrate proper design capability as its core competence (Kimbell, 2011; Holmlid & Evenson, 2008). The principles for service design include user-centered, co-creative, and holistic evidencing and sequencing (Stickdorn & Schneider, 2013).

With the user-centered principle of service design and the assistance of a service design tool—customer journey map—this paper will focus on spectators' experience and explore its pain points and design opportunities. This research adopted the value of multidisciplinary and co-creation from service design, communicating with the Company to ensure consistent objectives.

3. The Case: HADO

Meleap, a Japanese startup that develops AR games, created Techno-Sports, which combined AR with traditional sports. The Company also founded HADO to shape the competitive sport of the future. HADO is a 3-on-3 team sport that combines AR and dodgeball. In a HADO match, players can shoot energy balls and block the other team's attack with a shield. At the end of the match, the team with the higher scores wins. HADO is the first competitive AR sport in the world. One of the researchers is a designer from Meleap; therefore, Meleap agreed to assist with this study on HADO and to provide necessary assistance and related information.

4. A Discussion on Spectator experience of HADO Matches

4.1 Aim

This study aims to investigate spectator experience in a competitive AR sports event in terms of service design. By studying HADO events, we are able to gain an understanding of their current service conditions and to analyze their challenges and shortcomings. Through design thinking and multidisciplinary collaboration, we proposed a direction to optimize the spectator experience of HADO events and summarized the issues and challenges for improving the spectator experience of AR sports events.

4.2 Research Process and Methods

To understand the problems and flaws in the spectator experience of AR sports events from both a physical and virtual perspective, we conducted a two-phase investigation into Meleap's HADO. The first phase investigated HADO's live sports events, including participating in the entire HADO Summer Cup event in Tokyo during August 2019. The second phase examined HADO's online sports events. Questionnaires and semi-structured interviews were conducted to obtain qualitative and quantitative data. These data then helped pinpoint the factors that affect spectator experience, and at the same time gave the researchers a clear direction on how to optimize HADO's spectator experience effectively (Figure 1).

Figure 1 Research process and methods

4.3 A Discussion on the Issues in the Spectator Experience of HADO's Live Events

One of the researchers participated in the entire 2019 HADO Summer Cup event in Tokyo during August 2019. The content and procedures adopted in this research had previously approved by the company. We conducted questionnaires with spectators at the games to obtain feedbacks on their experience of the event. Finally, based on our field observation and the results from the questionnaires, the researchers constructed a customer journey map to identify the pain points and also explored design opportunities for better spectator experience.

FIELD OBSERVATION

Field observations at the HADO event's venue were conducted and photos and videos of the spectators' participation was taken. It was discovered that the way the audience in the venue watched AR games is quite different from the way traditional sports games were watched. In fact, all the AR special effects are not visible to the naked eye; the only way for the spectators physically at the game to see those AR effects is by looking at the projector screen, where the game footages with all the effects were projected to (Figure 2). In contrast, if they chose to focus on the real actions on the stage, they would only see players running around with awkward postures.

Figure 2 The way the spectators watch the game in the venue (left) versus the way the game looks like on the projector screen and online (right).

QUESTIONNAIRE SURVEY AND RESULT

The questionnaire used in this phase was approved by Meleap beforehand. The questionnaire includes questions about motivation for participating, participation experience, past experience of HADO playing, understanding of the game format, potential improvements for the game and net promoter score (NPS). NPS represents a customer's willingness to recommend a product to others, and is an indicator that can accurately quantify a customer's perception and directly reflects a customer's loyalty to a company or its services (Reichheld, 2003). The higher the number, the more likely a company will experience growth.

82 questionnaires were collected and the results were compiled and presented in Fig 3. The results show that 32% of the spectators attended the event out of curiosity toward AR sports, and approximately 60% of them attended the event for the first time. Since they were just introduced to the game and had little knowledge about HADO, they had to observe the game to understand its format. In addition, most spectator members pointed out that having to watch the game on a projector screen to see the AR effects is the part that needs to be improved the most. The overall NPS score of 10 points is a clear indicator that the current spectator experience does need to be improved.

Question	Results
NPS Score	NPS 10
Where did you hear about the event?	70% by referral. The rest either have participated in HADO events before or heard about it on the social media.
Why did you come to see the event?	32% of them came to the event out of the curiosity for AR sports events.
Have you seen or participated in a HADO event?	Approximately 60% of them came to see the game for the first time. 30% of them has played and watched HADO before. 10% of them have never played HADO but have been to an event before.
Past HADO experience	Only 30% of the audience has experienced HADO before.
Understanding of the format	50% learned about the format by watching; 20% by reading the event brochure and the last 30% already knew about the format in advance.
What are the improvements you would like to see about this event?	Most of the respondents pointed out that having to watch the game on the projector screen needs to be addressed. Other parts that need to be improved are: event schedule, performances, activities and merchandise store.

Figure 3 Survey Results from Spectators of HADO Live Event

After future analysis, the spectators were divided into different groups based on the feedback from the survey (having played or participated in HADO events), combined with the respective NPS. The result is shown in Fig 4. The first quadrant is the target spectators of this event—those who have never played HADO, with this event being their first. These accounted for more than half of the respondents and yet only had an NPS of 4, which is far from ideal and is a clear indicator that spectator experience needs to be optimized. The third quadrant represents the spectators who had played and participated in HADO events before, and the number of respondents is second only to the target spectators. However, this group

is more willing to recommend HADO events to others. It is plausible that spectators may be more willing to recommend HADO events if they have played HADO themselves, with more knowledge of the game as a player and a spectator.

Figure 4 Spectator Group Analysis

CUSTOMER JOURNEY MAP

A customer journey map is often presented as a part of the research deliverables of a design process (Følstad & Kvale, 2018). It visualizes different stages of a user's experience of or interaction with a product or service, allowing each detail of the journey to be reviewed. The map shows a customer's characteristics, emotional responses and problems while interacting with services (Ho & Sung, 2014). It helps us to find gaps in customer experience and explore potential solutions, so that we can make intangible experience visible and with the map, facilitate a common understand between team members (Stickdorn & Schneider, 2013). While constructing a customer journey map, it is essential to clarify a service's touchpoints where interactions with users happen, and to understand users' perception and thoughts towards a service by collecting qualitative data, such as interviews and photographs. Based on the abovementioned field observation and insights from the questionnaires, a customer journey map was constructed and illustrated in Figure 5. The map details the pain points of the spectator before, during, and after watching the event.

From the emotional lines in the customer journey map, we can perceive that spectators' unpleasantness occurs at the points of entering the venue, watching the game through the projector screen, and waiting for the game to begin. However, these issues are independent events. We found that before watching the game, a spectator typically felt interested and excited about the AR sport event at first, but this sense of surprise and excitement would gradually reduce after he or she started watching the game. Whether it's a lack of understanding about the game, the way of watching the projection screen, or other issues,

it causes the overall experience of watching the game to be dull. Based on the above discussions and findings, this study summarized how the service could be optimized in the following 3 points:

1. Lack of understanding of the event and ruleset before watching the event: the spectator had to learn about the details of the game while watching, which prevented them from actually getting engaged in the game. As most spectator members had never played HADO before, it was difficult for them to understand the technicality and difficulty of the game, not to mention imagining a player's perspective with AR goggles on. If spectator members have the chance to understand the details of the event beforehand and even to play HADO themselves, they can focus on the competition and will have a more enjoyable experience during the game.
2. User experience issues resulting from the way the game is watched: spectator members who had never been to an AR sports event became very excited at the beginning of the event. However, the excitement gradually faded as time went on, especially when experiencing frustration while watching the game. The greatest pain point in watching the game was that the spectator had to look up at the screen to see what was happening in the game, even though the players were playing right in front of them. They had to constantly switch between looking at the players and the screen, which caused strain on the necks. More importantly, using a projecting screen is fairly common in traditional sports events and concerts; thus, the features of AR are not demonstrated in live events, leaving an expectation gap after watching the game.
3. Lack of interaction during the game: there was no interaction among the spectator members or between the spectators and the players during the game, which meant that the sense of engagement might be absent while a spectator was watching the game.

Figure 5 Customer journey map of a HADO event, which includes users' actions, interaction scenarios, emotions, pain points, touchpoints and stakeholders before, during and after watching the game, giving a clear presentation about the problems and issues in the spectator experience. (Visit the following link for CJM: <https://reurl.cc/qD4zbN>)

4.4 Discussions on the Issues of Spectator Experience in HADO's Online Events

After the survey at the physical event in phase 1, we had a certain level of understanding of the issues of spectator experience in HADO events. The research in phase 2, with interviews and questionnaires, focused on the experience of live streaming content of the 2019 HADO Summer Cup.

INVESTIGATION PROCESS

First, we tried to understand the interviewees' past experiences in watching HADO events, and asked them about their understanding and perception of AR, as well as expectations towards AR sports events. Next, we introduced the basic game details and rules of HADO to the interviewees. All the provided information is according to official information from HADO. Then we conducted interviews to discuss their opinions and expectations towards HADO events. Lastly, we asked the interviewees to watch 2019 HADO Summer Cup online to simulate the real situation of watching an actual game and then asked them to fill out a questionnaire. Once completed, we continued the interviews, in which we provided them with video clips taken directly from the game venue and solicited their opinions to obtain more feedback on attending the game in person, in addition to their online spectator experience (Figure 6).

Figure 6 Interviewees watching the event online and getting interviewed

PARTICIPANTS

HADO combines e-sports and traditional sports. To further understand how those who watch games online think about HADO events. A total of 10 participants were interviewed and their backgrounds are listed in Figure 7.

No.	Gender	Age	Occupation	Years of watching	Channel	Match type
A	Male	24	Research assistant	15	Online, TV	Football, DOTA, Card
B	Male	39	Engineer	10	Live, Online, TV	Basketball, Badminton, DOTA
C	Male	41	Product designer	5	Live, Online, TV	Basketball, SLG, Card
D	Male	35	Brand agency	20	Online, TV	Football, Basketball, Card
E	Male	35	Industrial designer	4	Online, TV	Football, Racing car
F	Male	24	Back-end Engineer	15	Live, Online, TV	Baseball, Basketball, DOTA, Olympic
G	Male	31	Data analyst	10	Online, TV	Basketball, Tennis, Olympic
H	Female	30	Translator	6	Live, Online, TV	DOTA
I	Female	20	Student (eSport)	1	Live, Online	DOTA, RCG, FPS, Card, PS4
J	Female	25	UI Designer	5	Live, Online	DOTA

Figure 7 Participants backgrounds.

CONTEXTUAL ANALYSIS

Contextual analysis is the process of interpreting, consolidating and communicating a user's work activity data (Beyer & Holtzblatt, 1998). The main point of contextual analysis is to convert raw contextual data into work activity notes, and to convert work activity notes into work activity affinity diagram (Rex & Pardha, 2012). In this study, the interviews were transcribed, and the transcription was reviewed to check for any differences before being encoded. The integration and communication process compiled the work activity notes into a work activity affinity diagram (WAAD) to determine the problem categories and insight

opportunities. We compiled the interviewees' feedback into a WAAD (Figure 8) and then matched the issues to different stages of a spectator's journey during the game (Figure 9). The results were shown in Figure 10.

Figure 8 WAAD Analysis – Transcribe, encode and compile interviews to clarify user's problem categories and insights.

Stage				Before watching				Watching match				After watching			
Scope		Considerations	Motivation	Past Experience	Visual effect	Interactivity	Understanding	Atmosphere	Broadcast	Gap	Rewatch				
<div><div></div><div>Insight</div></div> <div><div></div><div>Pain point</div></div>	Player's personality is one of the considerations for watching the game			The reason for watching the game is to see the performance of the players	Spectators have their own experience of playing, which can improve understanding of the event	AR sound and light effect is not strong	Viewers easily ignore player information	Insufficient interaction between player and audience	Most audience don't understand the details of game	The conflict between the AR effect and the real environment makes the audience have a negative experience	Spectators need anchors to help clarify the highlights of the game	There is a gap from the original expected experience, which affects experience satisfaction	The novelty of the game will affect the willingness to watch the game again		
	The size and number of screens is one of the considerations when going to the competition			The reason to watch the game is to improve your own playing skills	Scoring status is not obvious	Insufficient player recognition	The score of the game is messy and unfocused, making it difficult to understand the situation	The perspective of broadcast is difficult to understand the game	There is a gap from the original expected experience, which affects experience satisfaction	The novelty of the game will affect the willingness to watch the game again					
<div><div></div><div>Expectation</div></div> <div><div></div><div>Difficulty</div></div> <div><div></div><div>User feedback</div></div>	<div><div></div><div>C-6-2</div></div> <div><div></div><div>J-6-1</div></div> <div><div></div><div>G-5-7</div></div> <div><div></div><div>E-2-6</div></div> <div><div></div><div>16-2</div></div>	<div><div></div><div>A-1-2</div></div> <div><div></div><div>D-1-1</div></div> <div><div></div><div>J-1-2</div></div> <div><div></div><div>E-1-5</div></div> <div><div></div><div>F-3-6</div></div>	<div><div></div><div>F-1-9</div></div> <div><div></div><div>G-1-2</div></div> <div><div></div><div>B-1-1</div></div> <div><div></div><div>C-1-2</div></div> <div><div></div><div>H-1-2</div></div>	<div><div></div><div>D-3-5</div></div> <div><div></div><div>F-5-5</div></div> <div><div></div><div>F-5-3</div></div> <div><div></div><div>C-3-5</div></div> <div><div></div><div>A-5-1</div></div> <div><div></div><div>D-5-5</div></div> <div><div></div><div>G-5-2</div></div>	<div><div></div><div>E-5-9</div></div> <div><div></div><div>F-5-3</div></div> <div><div></div><div>A-4-17</div></div> <div><div></div><div>D-6-2</div></div> <div><div></div><div>V-4-8</div></div> <div><div></div><div>B-5-7</div></div>	<div><div></div><div>E-6-1</div></div> <div><div></div><div>A-4-5</div></div> <div><div></div><div>C-4-3</div></div> <div><div></div><div>H-6-5</div></div> <div><div></div><div>C-6-3</div></div> <div><div></div><div>D-6-4</div></div> <div><div></div><div>F-4-17</div></div>	<div><div></div><div>G-6-1</div></div> <div><div></div><div>A-6-3</div></div> <div><div></div><div>C-4-18</div></div> <div><div></div><div>H-6-5</div></div> <div><div></div><div>E-4-7</div></div> <div><div></div><div>B-4-2</div></div> <div><div></div><div>D-6-4</div></div>	<div><div></div><div>E-4-4</div></div> <div><div></div><div>C-4-18</div></div> <div><div></div><div>G-4-3</div></div> <div><div></div><div>F-4-8</div></div> <div><div></div><div>B-4-2</div></div> <div><div></div><div>D-6-4</div></div>	<div><div></div><div>D-4-3</div></div> <div><div></div><div>E-4-17</div></div> <div><div></div><div>G-4-3</div></div> <div><div></div><div>F-4-8</div></div> <div><div></div><div>B-4-2</div></div> <div><div></div><div>D-6-4</div></div>	<div><div></div><div>F-4-19</div></div> <div><div></div><div>E-4-17</div></div> <div><div></div><div>G-4-3</div></div> <div><div></div><div>F-4-8</div></div> <div><div></div><div>B-4-2</div></div> <div><div></div><div>D-6-4</div></div>

Figure 10 User's Insights from Contextual Analysis.

1. BEFORE WATCHING:

The interviewees' main motivation for watching games in the past was about techniques: they watched games to observe the players' techniques and learn from them.

"People who watch e-sports are mostly players themselves. They watch to improve their own skills" (D-1-1)

"I want to watch the amazing pros play to improve and inspire myself" (J-1-2)

Spectator with prior experience had little trouble understanding the game: most interviewees who had experienced the game before had a certain level of understanding of the game, and therefore could easily enjoy watching it.

"I have played this myself so I know when exciting things happen in this game" (F-1-9)

"I have taken tennis lessons before so I know how exciting this game can be. That is why I want to go and see the game." (G-1-2)

2. WATCHING THE MATCH:

The AR visual effects, as well as the sound and lighting effects, need to be optimized and improved: most interviewees cared a great deal about the AR visual effects and would compare them to the ones they had seen in other sports events. In general, they had higher expectations for the visual, sound and lighting effects.

"There should be different effects when a ball hits the wall or a person." (F-5-5)

"The game would be more interesting if the sound and lighting effect were in sync with the ball hitting an opponent." (D-3-5)

Lack of interaction while watching the game: there was not enough hype in the online discussions about the game. The game did not offer the spectator much opportunity for interaction, which would also affect the spectator experience and people's willingness to go and watch the game

"If the live spectator could hear what the players are saying on the stage, the game would be even more thrilling." (G-6-1)

"Other than cheering for players with a cheering megaphone, the spectator did not have much interaction with the players." (E-6-1)

Spectator's lack of understanding of the rules resulted in a poor spectator experience: many details of the rules are not explained clearly during the game. On top of this, most spectator members have never played HADO. Therefore, the spectator experience is affected when the spectator does not fully grasp why things are happening in the game.

"You get a basic idea about the rules after watching the illustrations but you will only know the details after playing the game yourself." (D-4-8)

"I do not know some of the rules nor why certain techniques are considered advanced in the game." (C-4-3) "

Potential negative experience resulting from the way the spectator watches the game: the locations of the actual players and those of the projected players on the screen can affect the spectator's immersion in the game.

"Watching the game live is like watching the players punching the air, which affects the spectator immersion." (A-6-3)

"There is nothing cool when you just watch the players. I think this will affect the spectator's perception on the players." (H-6-5)

3. AFTER WATCHING:

Expectation gap in AR sports events: most interviewees had set their expectations towards AR effects based on movies and anime that they had watched—they expected to see next-level effects. However, there was a big gap between their expectation and reality and, as a result, most of them were not willing to return.

"I thought it would be fancier. I thought I could see something flying and spinning, all those spectacular and amazing effects. That would have been more entertaining. HADO is all about visual effects so the game should be more entertaining." (D-4-11)

"At first, I thought I could see some fancier moves, like curveball or something." (B-4-5)

"This game is all about both sides fighting. They should make it look like anime, like Dodge Danpei Manga where the ball would loop-de-loop or like The Prince of Tennis, where the players play like they have superpowers." (C-4-27)

Game excitement will affect the spectator's intention to return: with a lack of willingness to go and watch the game, whether or not future events have any surprises or special features will be the deciding factor for the spectator to come back.

"It depends on if HADO comes up with something new. If not, I will not come back." (F-4-19)

"I don't want to come back to another HADO event. It is not what I expected if this is all there is to it." (D-4-16)

QUESTIONNAIRES AND QUANTITATIVE ANALYSIS RESULTS

This study mainly relies on qualitative analysis, supplemented by quantitative data. The questionnaires for the satisfaction toward the HADO's online event in this study included customer loyalty indicators, experience satisfaction and other factors that interviewees believed were crucial to their spectator experience. Each value that an enterprise provides to its customers is called a driving factor, which creates customer loyalty. When these factors have proper interaction, customer loyalty will gradually build up (Naoki Endo & Yukiko Takei, 2015). The results obtained from the questionnaires were analyzed and compiled using the slope of linear regression to understand the correlation between loyalty indicators, experience satisfaction and the driving factors. The higher a coefficient of determination (R^2) is, better model explains and predicts future outcomes, which provides a clear direction for improvement. Experience satisfaction questionnaires comprised five factors, including sensory factor, emotional factor, service experience, thinking factor and association factor (Huang, 2007; Schmitt, 1999). With the exception of NPS, the questions in this study's questionnaire all used the Likert scale.

Figure 11 Quantitative Analysis Structure.

Customer loyalty is a quantifiable indicator that measures a customer's devotion. This study uses *overall customer satisfaction*, *rewatch intention* and *net promoter score* (NPS) to measure customer loyalty. The result shows a -50 of overall NPS, average 3 in overall customer satisfaction and an average 2.6 in rewatch intention, a clear indicator that customer loyalty needs to be improved. The interviewees considered game excitement as the most important driving factor, for which HADO only scored a mediocre 2.9.

The study used the slope in linear regression to compile data and understand the correlation between customer loyalty indicators, experience satisfaction and driving factor satisfaction; it discovered that, other than moderate correlation between NPS and overall customer satisfaction, there is no correlation in other combinations. The results from the qualitative interviews show that most interviewees have higher NPS and overall satisfaction because the event is something they have never experienced before. However, rewatch intention truly reflects viewing satisfaction, therefore representing the most relevant indicator when it comes to the experience itself.

Rewatch intention and *game excitement* (first-ranked driving factor) are moderately correlated (coefficient of determination $R^2 = 0.51$). Therefore, enhancing game excitement will effectively boost the spectator's rewatch intention. To understand factors that affect game excitement satisfaction, we analyzed game excitement and *viewing satisfaction* and discovered the three aspects with the highest correlation to game excitement: *rules understanding*, *sight and sound effects* and *augmented reality effect*. Optimizing these three factors will boost the spectator's satisfaction toward game excitement, which will in turn affect rewatch intention.

5. Results

After comparing the questionnaires and contextual analysis of both live and online HADO events, we verified that the issues are consistent. By combining qualitative and quantitative data, we were able to pinpoint the factors that truly affect spectator experience, giving us a clear direction on how and where to assign resources to effectively improve it. Lastly, we listed the core pain points and direction for optimization of HADO's spectator experience (Table 1).

Table 1 Spectator experience Issues in HADO's Live and Online Events

	Before watching	Watching game	After watching
Phase I Questionnaire with live spectator	Lack of understanding of the event Curious about AR sports events	The way to watch the game needs optimization Lack of interaction while watching the game	Different than previously expected
Phase II Questionnaire three aspects in the experience factor that affects rewatch intention	Level of understanding of the game rule	Sight and sound effect AR effect	
Contextual analysis Pain points and discoveries	Having experience playing games will increase understanding of the game Poor spectator experience due to a lack of understanding off the rules	AR, sight and sound effect require improvement Lack of interaction while watching the game	A gap from the original expectation affects experience satisfaction. The novelty of the game will affect the willingness and interest of watching the next time
Concluded issues	Self-experience, understanding of the game format and details	Sight and sound effects, AR effects, interaction while watching	Expectations for AR events

A lack of understanding of the game rules and without prior HADO experience resulted in poor understanding of the game, which was the main issue for the spectator before watching. Therefore, it is necessary to help the spectators to understand the game. However, HADO cannot be played at home; we can only play it at some of the HADO stores. Thus, it is suggested that Meleap should utilize other contact points (website, mobile app, etc.) to allow users to get a glimpse of what it is like to play HADO, which will help them understand the game better while watching.

AR is a technology that provides unique visual experience; however, some spectator members believed that the AR effects in the game, as well as the light and sound effects, were not impressive enough, and deteriorated their satisfaction of in-game excitement. Moreover, we found that a lack of interaction during the game left so most spectators without memorable or interesting experience.

This researcher also suggests that the Company combine online and offline event communication channels to provide spectator with a seamless user experience, in order to enhance game interaction (Mirsch, Lehrer and Jung, 2016; Trenz, 2015). Finally, to reduce the expectation gap toward an AR sports event after watching the game, the Company can refer to the visual effects from other e-sports events, anime, video games or movies, and incorporate them into HADO's AR spectator experience design.

6. Conclusion and Suggestions

6.1 Challenges and Issues of AR Spectator Experience

Although we pointed out the problem of lacking understanding of the game rules in the previous discussing on HADO, it's actually a problem that all games will face. Therefore, it won't be discussed in this section. Based on the discussions and analysis on the issues of spectator experience in HADO events, this study categorized the challenges and problems of AR spectator experience into two aspects: user expectation and AR characteristics. These can serve as reference for any future studies involving AR event spectator experience (Figure 12).

Figure 12 Challenges and issue in AR Spectator experience.

Challenges and issues of AR spectator experience as a result of high user expectations: for most users, watching an AR sport event is a completely brand-new experience. They base their understanding of AR on the special effects they have seen in animations, movies, anime and videogames—which have very sophisticated effects. Being used to such high-quality visual and sound effects, they have very high expectations and standards toward AR effects.

Issues and challenges from AR sports events: compared to traditional sports events, the biggest difference with AR sports events is that the special effects on balls or other objects can only be seen on screen. However, this combination of real and virtual worlds restricts the spectator's interaction with the players. In a traditional sports event, live spectator members can see the game with their own eyes, and the players can hear and respond when the spectator cheers for them. However, in an AR sports event, the players are in a mixed (virtual and real) environment once they put on AR goggles. Even though they can see the real environment, a wall still exists between them and the reality. This relegates the players and the spectator in two different environments with little to no connection or interaction.

6.2 Design Opportunities

Based on the above discussion, we divide the design opportunities in the future into two parts: 1. Way of watching games, 2. Entertainment.

Previous discussion mentioned that the way of watching game through a projection screen is still to be optimized. The way of watching game is the basis element of all game watching experience. Only with a good and comfortable way of watching can user meet the basic needs. Although The most ideal way is providing spectators with an AR device that can simultaneously see the AR effect of the game, high cost and technological difficulties causes it unachieved currently. We suggest that in the future, developing an application as the second screen for spectators, such as a mobile App, or a device which is provided at the off line venue to assist game watching. These tools should be helped audience to get real-time information about the game, and it's a role of an assistant. In addition, due to the limit of AR technology, the playing field must have at least two walls to position player's location, and with the placement of the projection screen. These causes that spectators have only single watching angle and they are in an undesirable situation. So, we could consider how to design a venue that can break the established pattern. Summarize the design opportunity about the way of watching are divided into physical and digital channels: physical channel is spatial planning and design of the physical field; digital channel is App or software design.

The foregoing discussion found that AR games bring a lack of interactivity between physical and virtual environment, and it is difficult to establish a connection between the spectator and the event. In addition to increase activity in live events is necessary solution. however, with the development of the Internet, the integration of online and offline cross-channel experience is an aim we should pay attention to. we suggest that a digital tool can be used to develop some interactions and activities, it can motivate the motivation of connection and build the relationship of offline and online spectators, and spectators and players.

For example, using app to create activities that help spectators interact with the game, establishing activities that both online and offline spectators can participate in together, etc.

6.3 Future Work

This study is the first to explore and discuss user experience design in watching AR sports events. With a unique case study, this research conducted an in-depth analysis of the current issues facing the experience of watching AR sports events, and proposed suggestions for optimization. We will continue to explore other design strategies to optimize the experience of watching AR sports events and seek the best solution by multidisciplinary co-creation. We will then test and verify this strategy to determine an appropriate method to test service design prototypes in spectator experience.

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