Studying the Extended Reality and Its Impact on Improving the Performance and Effectiveness of Egyptian Airports

Mayada Mohamed Abdel-Hammed

Badr Institute of Science and Technology, Higher Institute for Tourism and Hotels, Egypt

ARTICLE INFO	Abstract
	Immersion technologies including mixed reality (MR), virtual reality (VR), and augmented reality (AR) are together referred to as extended reality (XR). Virtual reality immerses the user in a digital realm, augmented reality combines the actual and digital worlds, and mixed reality combines both. One of the best ways to visualize written information is through XR. In order to increase productivity, safety, and efficiency, the airport has begun utilizing XR in specific applications. In addition to providing entertainment for their customers, airlines are employing XR to assist in the training of flight attendants and aircraft mechanics. The range of sectors and applications where XR can be useful is expanding. Airport operators may find that XR, which is utilized in other industries, may also be applied in the airport setting. Through the qualitative analysis of interviews with experts in Egyptian airports and the distribution of a show card on representatives of the Egyptian aviation industry during the conduct of in-depth semi-structured interviews with them, the current paper seeks to investigate the potential opportunity of applying extended reality in Egyptian airports. Insights about extended reality technologies and solutions that can be used in Egyptian international airports are provided in the paper's conclusion.

Introduction

The acceleration of the global economy's digitalization was one of the major developments of the COVID-19 era. It showed up, among other things, in the increasing use of immersive technologies. Ignoring extended reality (XR) can have a detrimental impact on their profits because the competitiveness of global economy actors working in the tourist sector directly depends on their inventiveness and quick trend-following (Podolskaya and Anastasiia,2023).

   XR technology can enhance airport operations by improving customer experience and efficiency. Employees can use virtual reality for training in challenging situations, like dealing with upset passengers, helping those with a fear of flying, or assisting passengers with disabilities. The goal is to use XR training to create a better experience for travelers (Chen and Fragomeni,2022).

Research aims

1- Analysing the current situation of Egyptian Airports.
2- Investigating the use of extended reality technologies in international airports in Egypt.
2- Studying successful global experiences of applying extended reality in international Airlines.
4-Clarify the Challenges facing Egyptian airports to implement the extended reality and make recommendation for its development.

1-Literature review

1-1-Definition of Extended reality

Extended reality (XR) refers to technologies that change our perception of reality by adding digital features to the physical environment (Kaplan et al.,2021). This includes augmented reality (AR), mixed reality (MR), and virtual reality (VR), among others. XR technologies aim to enhance our experiences by blending the real and digital worlds (Alnagrat et al.,2022): -

- Virtual reality (VR), which provides a completely immersive experience. Through the use of a specialized headgear or glasses, such as the Oculus Rift headset, the user effectively loses awareness of the outside world and enters a computer-simulated environment.

- Augmented reality (AR) mixes the real world with digital elements by placing digital images or information in our physical surroundings. In contrast, virtual reality (VR) creates a completely artificial environment. AR stays connected to the real world and doesn't need any special gear; you can just use a regular smartphone that has a camera.

- Mixed reality (MR) blends the real world with digital elements, allowing users to interact with virtual objects as if they were physically present. For instance, a person can move or change these virtual items just like they would with real ones. This is different from augmented reality (AR), where users can see information or images added to their view but cannot interact with them.
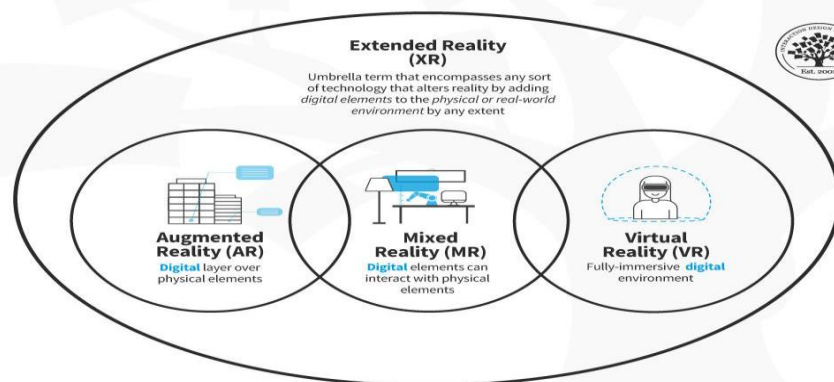
Source: Joskowicz,2023
Figure 1. Concepts of AR, MR, VR and XR

XR refers to technologies like AR, MR, and VR, which combine elements of the physical world with the digital world.

As a result, the phrase "extended reality" does not relate to any particular technology; rather, it encompasses any current or potential future technologies that modify reality, either by fusing the digital and physical worlds or by producing a completely virtual environment (Adil et al., 2024).

1-2-History and Evolution of Extended Reality

The following content divides the history of the XR into two sections: Art History and Technical History: -

1-2-1- Art History: This section focuses on art. In the 15th century, an Italian engineer named Giovanni Fontana created a system called CAVE. This system used large lanterns to project images onto the walls of a room, allowing people to experience art in a new way. This was the first instance of what we now understand as immersive and virtual reality (VR) concepts (Arnaldi et al.,2018). Over the next few centuries, many artists and engineers helped develop the idea of immersion further. In 1958, Antonin, a well-known inventor and artist in theater, defined the modern concept of VR. He studied important elements of VR, like characters, objects, and images. His findings not only aided the creation of modern theater but also represented a significant step in the development of the illusionary world (Artaud and Richards, 2018).

Science fiction has played a significant role in shaping the idea of virtual reality (VR). During the 1980s and 1990s, various science fiction stories explored adventures in virtual worlds filled with futuristic technology. Works like "True Names," "Neuromancer," and "Snow Crash" showcase different ways to engage with these virtual environments, introducing concepts like online communities and VR headsets. While these ideas may differ today, they inspired scientists to think about future possibilities. The 1992 film "The Lawnmower Man" further educated the public about VR. Then, in 2002, "Minority Report" showed how users interact with virtual interfaces in real life, expanding the idea of extended reality (XR) beyond just virtual environments to include interactions with the physical world (Dick,2016).

1-2-2- Technical History: In 1962, Heilig created a machine called Sensorama to let people watch videos in a more engaging way using 3D visuals and sound. He was inspired by Antonin's idea of a virtual theater and wanted to build an "Experience Theater." Sensorama used Antonin's VR ideas to create a new way to engage with virtual environments. It is one of the first VR systems, but it is large and not easy to move. To address this, Robert Sproull and Ivan Sutherland invented a portable device known as 'The Ultimate Display' in 1965. This device is recognized as the first head-mounted display (HMD) in virtual reality. They brought together the concepts of VR and portability, leading to the idea of HMDs. In the decades that followed, scientists and companies built their VR devices based on the HMD concept (Xing et al.,2021).

In 1984, NASA's Ames Research Center created the HMD system called 'The Virtual Environment Workstation'. This system offered better graphics and could track the user's head and finger movements, unlike 'The Ultimate Display'. The Virtual Environment Workstation set the standard for how users interact in virtual reality, including head movements and gestures. As graphics technology improved, researchers began to explore not just virtual worlds, but also how to connect with the real world. In 1994, Milgram and Kishino introduced the idea of moving from reality to virtual environments, redefining virtual reality. They reviewed the development of the industry and established the concepts of VR, AR, and MR. Over time, the term XR emerged as a way to describe HMD technology, separating it into VR, AR, and MR based on how much virtual content each used. After 2010, XR technology became more common in the commercial market. The first well-known VR device, the Oculus Rift, launched in 2013,

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followed by the HTC Vive and Valve Index in the following years. In 2014, AR technology began to focus on mobile devices like Android and iOS, with ARKit and ARCore becoming key development tools. In 2015, the mixed reality device HoloLens was released. Overall, XR became available to the public from 2010 to 2020 (Xing et al.,2021).
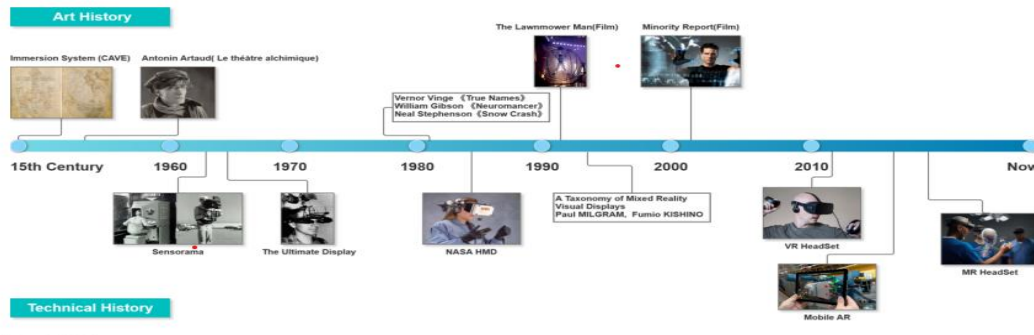

Source: Xing et al.,2021
Fig. 2. XR History

1-3-Extended Reality in the Tourism Industry

Using XR in tourism is not a new idea. For many years, the tourism industry has incorporated Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR) in different ways. VR has been used to create virtual museum exhibits, interactive tours, and destination previews, while AR has been used to provide interactive guides and enhance real-life museum exhibits; MR has been used to create immersive experiences that blend digital elements into real environments thanks to holographic contents (Sobhaeerooy,2023).

AccordingtoFigure3, reality can be divided into four components: reality itself (interpreted to enrich the experience), augmented reality (complementing the real world), mixed reality (reconstructing the real world), and virtual reality (reconstructing the physical tourism experience through a digital twin) (Podolskaya and Anastasiia,2023).
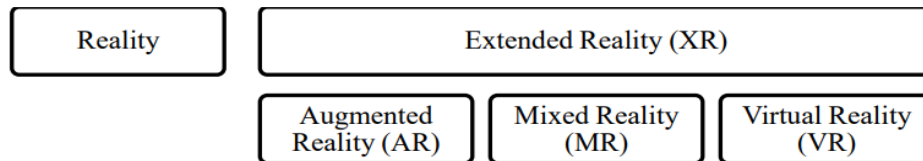
(**Source:** made by the authors)
Figure 3 –reality and immersive technologies

Coronavirus-related restrictions have been a catalyst for digitalization worldwide, while increasing the population's reliance on digital technology (Noha and Saeed, 2022).
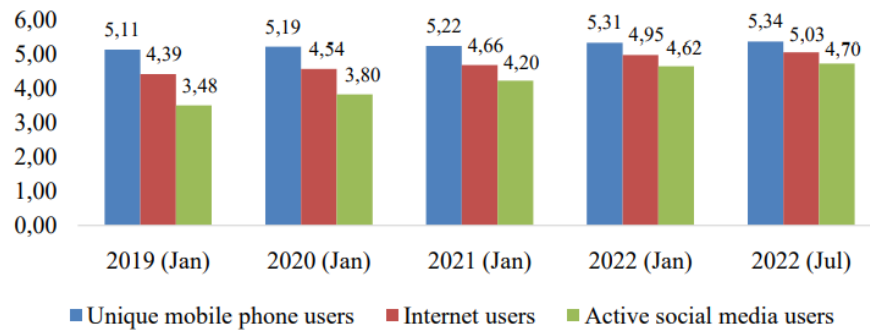
Source: Podolskaya and Anastasiia,2023

Figure 4 –Digital technology users worldwide, 2019-2022 (billion people)

Figure 4 displays the yearly increase in mobile phone users, internet access, and social network activity. As more people connect, the XR industry is becoming more diverse. Although technology challenges currently slow down XR development, the industry is on the verge of significant growth. Major tech companies are investing in XR, looking to create the next wave of computing technology. In 2021, the mobile AR market was valued at approximately 12.45 billion U.S. dollars, with projections to exceed 36 billion U.S. dollars by 2026. In 2022, the consumer and enterprise VR market was worth about 11.97 billion U.S. dollars and is expected to reach around 15.81 billion U.S. dollars by the end of 2023 (Podolskaya and Anastasiia,2023).

Virtual tourism is becoming a way to deal with the issue of social distancing. Travel companies can use new technologies even after the COVID-19 pandemic to highlight tourist spots in a positive light. There are two main reasons for this: -

1- Initially, extended reality fosters a feeling of immersion that captivates the user, potentially enhancing their trust in the destination and offering a thorough insight into it (Tsai, 2022).

2- Furthermore, as a method for preliminary exploration of tourist locations, XR establishes an initial perception of a destination, which is one reason some hotels provide virtual tours of their facilities and accommodations. This initial impression significantly influences the user's ultimate decision to make a purchase (Oncioiu, 2022).

1-4-Applications of Extended Reality in travel and tourism
The uses of XR in travel and tourism are as follows: -
1-4-1-Virtual travel and sightseeing: Virtual reality lets people explore places without being there physically. Many people wonder if virtual travel can truly replace the real experience of seeing, hearing, and feeling a new location. For example, the Patagonia Lake VR experience on Oculus Rift provides access to a beautiful glacial lake that is difficult to visit in person (Santoso,2022).
1-4-2-Virtual, immersive hotel tours: Vacationers can explore virtual hotel tours to better understand each hotel option before choosing the one that suits them best. Hotel companies now have a new way to connect with and provide a unique experience for potential guests (Guttentag, 2010).

1-4-3-Test drive excursions: Travelers can try out different parts of their trip to make the best use of their time once they arrive. Virtual activities might include helicopter rides, tours of parks, and boat trips.

1-4-4-Navigate interactively: AR assists in getting to your destination. Google Maps, the most popular navigation app in the world, uses AR for people walking. It uses the phone's back camera to find the user's location and places directions and other information on the screen (Dan Zhu ,2022).

1-4-5-Health & safety training: It is crucial for every business to follow government guidelines and rules for Coronavirus (COVID-19) safety. The travel and tourism sector can use XR in several ways to protect the health and safety of both employees and visitors.

XR technologies have changed how the tourism and hospitality sector's function. AR is being used to give visitors information about historical places, landmarks, and virtual tours of museums and art galleries (Boboc et al., 2022).

VR is being used to give customers virtual tours of hotels, letting them see the rooms before they book.

   XR is also being used to improve the experience of visiting art galleries and museums. Old paintings often hold many secrets about their meaning, history, and the artist who created them. With VR technology, visitors can gain a new way to appreciate art and possibly uncover some of its mysteries (Boboc et al., 2022).

The Louvre's VR mobile app, "Mona Lisa: Beyond the Glass," allows visitors to step into a virtual space where they can see Lisa Gherardini, the woman Da Vinci painted, as if she were alive today.

1-5-Extended reality (XR) in aviation

Applications of Extended reality in aviation, are as follows (Chen and Fragomeni,2022): -

1-5-1-Aircraft inspection training: Virtual reality training offers airlines and ground handlers a safe space to improve their skills in aircraft inspection. Using Virtual Reality (VR) for aircraft inspection allows training under different conditions for all types of aircraft, reducing the chances of mistakes during actual operations. The VR headset creates a visual airside experience, enabling teams to interact with virtual models of aircraft and perform visual inspections in simulated environments, such as a cargo bay or an apron.

1-5-2-Cabin crew training: Cabin crew members have a key role in making sure passengers are comfortable and safe. Before taking off, they must check that all safety equipment, such as flashlights, fire extinguishers, and life vests, is available and in good working order. They also need to watch for any smoke or unusual behavior from passengers. In addition, flight attendants are required to show all safety instructions before the plane departs.

   By using VR training instead of traditional classroom instruction, cabin crew can practice handling tough real-life situations, such as medical emergencies, potential crashes, or hijackings, in a virtual setting (Breeding et al., 2024).

   With the help of virtual reality technology, cabin crew members can make mistakes during training and learn from them. This results in improved performance when they are on the job.

1-5-3-Flight deck training: The flight deck team consists of the pilot and co-pilot who work in the airplane's cockpit. VR training tools help them learn about the cockpit and practice the skills

they need to respond quickly to different challenges. Using a virtual setup and head-mounted displays, pilots can get to know the cockpit controls and various situations they might encounter while flying.

1-5-4-In-flight entertainment: As virtual reality continues to grow and improve, airlines like Air France and Lufthansa are now using it to provide exciting entertainment for their passengers.

It is common for travelers to experience discomfort while flying because of noisy passengers, crying babies, or the general sounds of the airplane. This can make it hard for many people to relax and rest. Although wearing headphones can help block out some of the noise, it can still be challenging to ignore what's happening around you, which may be exhausting for those on long flights.

A VR headset and headphones can provide travelers with a great way to relax during a crowded flight. With VR, passengers can enjoy calming scenes that help them fall asleep or watch a recorded football game in an immersive 360-degree view.

1-5-5-Aircraft maintenance and MRO training: Virtual reality and augmented reality enable aircraft mechanics and maintenance technicians to learn how to inspect various aircraft parts from their desks. Airbus, one of the largest aircraft manufacturers, is utilizing VR technology with its portable RHEA kit. This kit includes a virtual reality headset, touchpads, and infrared cameras, allowing mechanics to inspect and fix aircraft in a fully immersive setting.

1-6-Uses of extended reality at the airports
- Help the passenger navigate the airport by taking them to different parts of the terminal, considering their likes and past purchases.
- Determine how much time the traveler has to enjoy the shops and restaurants at the airport.
- Share details about different types of food and drink options available at various price points.
- Guide customers to the restaurants by indicating the right direction and using arrows for clarity.
- Enable travelers to discover special deals available at the airport.
- Provide more information about shops and food vendors, including menus and 3D visuals of dishes or items.
- Connect clothing and accessory products to information about the weather at the traveler's destination.
- Alert passengers about the best time to board based on their location in the terminal and how far they are from the gate, and assist them in finding their way to the gate (Chen and Fragomeni,2022).

1-7-Experiences of foreign countries in using extended reality at the airport
Many major airlines have already implemented XR technology, such as (Picciano,2023): -
1-7-1- Qatar Airways: They are using VR training for several purposes to train ground handlers and line maintenance staff. Qatar Airways is using VR training simulation to transition from training programs that are instructor-driven to training programs that are learner-driven.

They are using a specially designed airside environment for Qatar Airways that includes different virtual planes from Boeing and Airbus. This setup helps provide realistic training and reduces both training time and costs.

1-7-2- Lufthansa: To provide its customers with in-flight entertainment, Lufthansa uses VR technology to provide a 360-degree immersive video viewing experience. The German airline uses VR to encourage customers to upgrade their seats from economy class to business class by showing them the 360-degree video of business class.

1-7-3- Air France: It is providing its passengers with immersive entertainment experiences through head-mounted displays. With partnering with XR companies like Sapizon Technologies, Air France has developed a special headset for passengers who fly on its Airbus A340.

1-7-4- Japan Airlines: It uses VR technology to enhance the training and skills of its aircraft mechanics. The engine run-up technique can be better understood by mechanics and maintenance engineers by using virtual reality training simulation programs. Also, the aircraft mechanics has the chance to put their expertise to the test in different scenarios, spot the errors and work on them.

2-Research Methodology

The study used a practical qualitative method that involved two stages of gathering and analyzing data. In the first stage, secondary data was gathered from earlier related studies and publications. In the second stage, primary data was obtained through interviews with 50 experts at Egyptian airports and a specially designed show card to assess the possibility of using extended reality at four specific airports: Sharm El Sheikh International Airport, Cairo International Airport, Marsa Alam International Airport, and Luxor International Airport. The show card served as a helpful tool to evaluate each airport individually. The cards were completed during detailed semi-structured interviews held in June 2024 with key individuals such as the Head of the State Security Bureau at Cairo International Airport, Head of Cairo Airport Insurance Investigation, Head of Egypt Air Technical Office, former president of the Egyptian aviation authority, and various managers. These interviewees were chosen for their extensive experience, knowledge, and expertise in the airport industry, particularly regarding operations and security. Five different methods have been used to assess technological tools, including the approach based on the judgments of industry experts, which helps gauge their satisfaction or perceptions accurately.

2-1-Results and discussion
The interviews were conducted with senior representatives of the airport industry. The interview questions were designed to cover the following points: -
- The benefit of applying extended reality in Egyptian airports.
- Uses of extended reality at the airport.
- Challenges of adopting extended reality technology in Egyptian airports.
- Requirements for implementing extended reality in Egyptian airports.
The upcoming Themes highlight the detailed interview analysis.

Theme 1: The benefit of applying extended reality in Egyptian airports

Possibility to adopt extended reality at Egyptian airports the interviewees were asked about the Advantages of applying extended reality in Egyptian airports. Central to this question; All of the interviewees agreed that the implementation of extended reality at the Egyptian airports will contribute to the following Increased training flexibility**,** XR training allows airlines to overcome constraints of operating physical mock-ups which are expensive and not always available. Trainees can access simulations anytime, anywhere. Enhanced safety**,** High-risk situations like emergency procedures and rare events can be accurately simulated to improve safety and readiness. Allows mistakes without real consequences. Reduced costs**,** XR training eliminates the costs of fuel, aircraft maintenance and environmental impact associated with real-world training flights. Lower travel costs as well since training can be distributed. Improved learning outcomes, XR training improves learning retention by up to 75% compared to training based on traditional methods. The highly engaging visuals and simulations lead to better understanding and application (Ross and Gilbey, 2023).

All the interviewees agreed that using extended reality in Egyptian airports will greatly improve their efficiency in the future. They mentioned that to adopt these technologies successfully, a clear vision and a solid plan must be created and executed not just by the Egyptian Airport Authorities, but also by other stakeholders, including private investors in the airline industry. The interviewees suggested that Cairo International Airport should be the first to adopt extended reality since it is Egypt's main airport and receives thousands of travelers daily. Others thought that smaller airports would also benefit from this technology, as it would be cheaper and easier to implement. Airports like Sharm El Sheikh International, Hurghada International, Marsa Alam International, and Luxor International were highlighted for this purpose. Furthermore, the interviewees stated that the rollout of smart airport tools should be balanced—not too fast and not too slow—to ensure a safe transition while also maintaining the airport's market position. They believe that using extended reality in Egyptian airports will help meet the needs of future generations.

Theme 2: Uses of extended reality at the airport

All the interviews agreed that extended reality could be used in Egypt's airports for in-flight entertainment, with the steady growth and advancements of virtual reality (Dorado et al,2024), airlines like Cairo International Airport, Sharm El Sheikh International Airport, Hurghada International Airport, Marsa Alam International Airport and Luxor International Airport are now using XR to offer immersive entertainment to passengers.

Egyptian airports can use extended reality for pilot and crew training. These virtual environments allow trainees to practice flying, emergency procedures, and other scenarios in a safe and controlled environment. This technology can be especially useful for learning complex procedures and practicing operations without the risk associated with real-world training. It will be implemented in all Egyptian airports specially that it has been requested by the International Civil Aviation Organization (ICAO).

Design and Prototyping, New airplanes models are made and tested using VR & AR. Before actual prototypes are constructed, engineers and designers can interact with it to visualize and improve designs. This could speed up the design process and identify potential issues early.

There are now actual experiments with this at Cairo International Airport.it was highly recommended to be used in Sharm El Sheikh, Hurghada and Marsa Alam International Airports.

Extended reality can enhance shopping experiences, especially in airports where travelers often rush. AR and VR can quickly provide guidance and assistance, helping shoppers find products before heading to their gates. For those with extra time, this technology can significantly improve their experience. Airports have a great opportunity to test these features, including virtual product demos and live streaming. Although this technology is not currently in use, it could be applied at Cairo International Airport, which is the busiest airport in Egypt.

   All interviewees agreed that using extended reality in airport advertising can be a useful way to share important information with travelers in an engaging manner. This technology can add eye-catching visuals and stories that help people understand the advertising message better. Extended reality aims to blend a stationary object with various sounds and images, creating an emotional bond with viewers, which motivates them to make purchases and significantly impacts airport advertising (El- Labban et al.,2023).

Theme 3: Challenges of adopting extended reality technology in Egyptian airports

The interviewees clarify many challenges affecting the implementation of extended reality in Egyptian airports as shown in the next part: -

- Human Skills: There are no trained personnel that may practice this type of work as there is no specific education and training.

- Infrastructure: There is no stable IT development that supports such a kind of technology. As well as, the current setting of the Egyptian airports would not help in implementing such a technology.

- Investment: A high cost of using such technology and its maintenance is a point. Thus, due to the current economic situation smart technologies is not one of our top priorities.

- Resources: we are facing a problem of offering the needed devices to apply extended reality in the Egyptian airports.

Theme 3: Strategy for future development

All of the interviewees have developed plans, but it is different from one to another. Those Future plans have not been confirmed yet due to the current economic situation.
The Interviewees agreed on the following:

- Implementing the smart airport technology should be done gradually based on short-term (within five years) and long-term (within ten years) plans.

- Extensive research and monitoring of the market, industry, competitors and Application of modern technologies

- Identify and map outsmart airport goals.

- Identifying the strengths and weaknesses of Egyptian airports to apply modern technologies.

- Identify new revenue opportunities at Egyptian airports.

- Define the optimal smart airport best practices.

- Develop the proper smart airport strategy explicitly delivered to the passengers.

-Develop a strategic plan and marketing calendar to apply the extended reality at the airport.

Table 1: applying extended reality in different Egyptian airports

Extended Reality	Cairo International Airport	Sharm El Sheikh International Airport	Hurghada International Airport	Marsa Alam International Airport	Luxor International Airport
Virtual reality	✓	✓	✓	✓	✓
Augmented reality	✓	✓	✓	X	X
Mixed reality	✓	X	X	X	X

It would make more sense to begin using extended reality at Egyptian international airports such as Marsa Alam, Sharm El Sheikh, and Hurghada. These airports cater to international travelers who would likely enjoy the improved travel experience that this technology provides.

3-Conclusion

The study revealed several findings about the significance of extended reality and its role in improving Egyptian airports. It pointed out that extended reality can bring many benefits to these airports through its three main types: Virtual Reality, Augmented Reality, and Mixed Reality. Experiences from other countries that have used extended reality in airports indicate that it is having a positive effect on airport operations, particularly by providing solutions to challenges that arise from the increase in passenger numbers, especially during busy times.

The evaluation of the show card provided information about the extended reality tools and solutions that could be adopted at each of the four major Egyptian international airports, along with the challenges of implementing these technologies. This information is valuable for shaping future development plans for Egyptian airports, especially regarding the introduction of smart technologies and assessing whether adopting these technologies is practical.

The results also showed that extended reality contribute to improving passenger experiences, cost savings, increasing efficiency, providing greater customer support compared to traditional methods, and reducing the workload on employees. The study also highlighted that forecasting enhances customer experiences, predicts flight demands, develops pricing strategies, reduces costs, increases revenue and predicts all factors that affect airport operations. Additionally, XR provide many benefits to airports such as simplifying operations, increasing safety and security measures, improving performance, providing superior services, assisting in maintenance operations, and exciting interaction with passengers and crew.

Through the discussion of the results, it is possible to identify the most important strengths and weaknesses related to the implementation of extended reality in Egyptian airports, as well as clarifying the most important opportunities and challenges. SWOT analysis for using extended reality in Egyptian airports:

Table 2: SWOT analysis for using extended reality in Egyptian airports

	Strengths	**Weaknesses**
Internal Factor	-Egyptian airports are a leading airport in using technological systems and applications. - Egyptian Airports is almost ready to move forward with its digital transformation in order to support Egypt Vision 2030.	- Labor shortage at airports. - lack of financial resources.
	Opportunities	**Threats**
External factor	- Egyptian International Airport considered the best airport in Africa, and one of the major carriers in middle east in terms of using the technological applications and systems for the convenience of their passengers worldwide. -MS as member of Star alliance and Arab Air Carrier Organization (AACO) can have the advantage of joint purchase of the new technology with a reasonable discount. -Implementing new technology with good marketing campaign and the strategic location of Egypt as a hub will enable Egyptian International Airport to increase its market share. -Expanding the fleet plan with latest technology.	-Poor technology use in Egyptian International Airport such as: Virtual reality, Augmented reality and Mixed reality to meet requirements of COVID19 pandemic and digital transformation. -Other competitors investing in technology in the region like, Emirates, Etihad, Qatar airways and Turkish airlines

4-Recommendations

The following suggestions are for the Egyptian Holding Company for Airports and Air Navigation (EHCAAN):

1. To make the most of extended reality, it is important to create both short-term and long-term plans that adapt the functions and operations of Egyptian international airports to use modern technology.

2. Short-term plans should focus on adding new technologies, such as Virtual Reality Apps, Augmented Reality, and Mixed Reality, since these can be easily installed without needing complex setups.

3. Long-term plans should aim to integrate extended reality in Egyptian airports to assist in training flight attendants and aviation mechanics, as well as to offer entertainment options for passengers. This also requires setting aside financial resources.

4. Resources should be allocated to advanced extended reality technologies and building the necessary knowledge and skills in-house to use these technologies effectively.

5. It is essential to provide the necessary financial and human resources to implement extended reality projects and ensure these projects deliver expected results.

It should also be noted that the Egyptian Holding Company for Airports and Air Navigation, along with the Ministries of Civil Aviation and Information and Communication Technology, should focus more on investing in a complete operations and information system, with special attention to using new technologies in airports.

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دراسة الواقع الممتد وتأثيره على تحسين أداء وفعالية المطارات المصرية

ميادة محمد عبد الحميد

معهد بدر للعلوم والتكنولوجيا، المعهد العالي للسياحة والفنادق، مصر

المستخلص باللغة العربية:

الواقع الممتد (XR) هو مصطلح شامل للتقنيات الغامرة مثل الواقع المعزز (AR) والواقع الافتراضي (VR) والواقع المختلط (MR). الواقع المعزز يمزج بين العالم الحقيقي والعالم الرقمي، والواقع الافتراضي يغمر المستخدم في عالم رقمي، والواقع الممتد هو مزيج من الاثنين معاً. الواقع الافتراضي هو طريقة رائعة لوضع المفاهيم المكتوبة في نوع من التصور. يستخدم المطار الواقع الافتراضي XR في تطبيقات معينة لتحسين الكفاءة والسلامة والإنتاجية. تستخدم شركات الطيران XR للمساعدة في تدريب المضيفات وميكانيكيي الطيران وكخيار ترفيهي لركابها. يتزايد عدد التطبيقات والصناعات التي يمكن أن توفر فيها تقنية XR فوائد . قد تنطبق تقنية XR المستخدمة في صناعات أخرى أيضاً في بيئة المطارات لمشغلي المطارات. يهدف البحث الحالي إلى استكشاف الفرصة المحتملة لتطبيق الواقع الممتد في المطارات المصرية من خلال التحليل النوعي للمقابلات مع الخبراء في المطارات المصرية وتوزيع بطاقة عرض على ممثلي صناعة الطيران في مصر أثناء إجراء مقابلات شبه منظمة معمقة معهم. وتختتم الورقة البحثية برؤى حول أدوات الواقع الممتد والحلول التي يمكن تطبيقها في المطارات الدولية المصرية.

الكلمات المفتاحية: الواقع الممتد، الواقع المعزز، الواقع المعزز، الواقع الافتراضي، الواقع المختلط، المطارات المصرية.