Towards enhanced Museum Services: The application of Artificial Intelligence at the Louvre museum, Abu Dhabi

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Abstract

This study sought to establish the extent to which the Louvre, Museum Abu Dhabi (the largest museum in the Arabian Peninsula) has deployed artificial intelligence tools to enhance its operations. Firstly, the study sought to identify the various AI tools that can be implemented in a museum setting. Subsequently, the study explored ways through which the identified AI tools were deployed to enhance museums' work processes and operations. Thirdly, the study provides an analysis on which of the identified AI tools have been implemented at the Louvre Museum, Abu Dhabi. Lastly, the study will make recommendations on how museums across the world can optimize AI technologies to embed a digital museum experience. The study adopted a qualitative research approach and a case study research design where the Louvre Museum, Abu Dhabi is the main case. Data was collected through literature review and semi structured interviews. Specifically, to answer research question 1, 2 and 4 of the study, data was collected by reviewing books and journal articles relating to digital technologies in museums. For research question 3, the researcher reviewed literature relating to the operations of the Louvre Museum, Abu Dhabi as well as interviewed one of the staff at the museum familiar with the implementation of AI technologies. Data was analysed thematically based on the research questions of the study.

Keywords

Artificial Intelligence, cultural heritage institutions, Louvre Museum Abu Dhabi

Kabata, Victor
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1. Introduction

Advances in digital technologies in the last decade have permeated every sector and changed the way we think, work, play, experience, communicate and consume (Ntalla, 2017, 2). The collaborative nature of these technologies has ushered in a new era where consumers participate more in choosing, creating and contributing to content (Black,2020). In the museum realm, this digital revolution has given rise to 'the participative museum'. Black (2020) describes the participative museum as:

> *A collaborative, outward facing, inclusive, polyvocal, participative museum that sets out to apply it core values and qualities to encompass the expectations of contemporary society.*

Further, 'a participative museum' exposes users to digital interactivity that is characterised by personalised, immersed and shareable experiences (Black 2020). For museums to offer a digitalised experience, they are expected to:

- Be user centric, that is, prioritise the needs and expectations of the users

- Embrace mobility and connectivity -provide free WIFI and seamless digital infrastructure

- Provide information on hybrid platforms- have both onsite and online presence including mobile

- Be global in nature – exposure to global cultures, trends and activities

- Allow users to personalise, participate, contribute and share experiences, that is, encourage users to become active contributors and even stakeholders in the museum

- Provide inclusive and polyvocal content (Black,2020).

The changing needs and expectations of contemporary museum users have prompted many museums to deploy digital technologies to keep pace with the evolving digital landscape. Indeed, Arts Connect (2018) notes that every museum requires an embedded digital approach and comprehensive digital content that ensures its young users are instantly and constantly connected. Further, a 2021 Museum Innovation Barometer global survey on the use of new technologies by museums revealed that many museums are adopting new technologies for audience related reasons such as to attract more online visitors, to diversify museum audiences and to increase the relevance of content creation and mediation (Tykhonova and Widmann, 2021).

While past studies on digitalisation within the museum sector have focused on museums in Europe, Australia, the Americas and parts of Asia, there exists scanty information on the deployment of digital technologies and in particular artificial intelligence tools in museums in the Middle East. This is evident from the 2021 Museum Innovation Barometer global survey where only 6% of the museums in Asia and Pacific region were included in the survey compared to 20% from the Americas and 66% from Europe. Indeed, none of the museums in the United Arab Emirates (UAE) featured in the survey (Tykhonova and Widmann, 2021). As such, there is dearth of information on the extent to which museums in the Arabian Peninsula have embraced AI technologies. This study seeks to fill this research gap by assessing the

Kabata, Victor
Assistant Professor, Sorbonne University Abu Dhabi

extent to which the largest museum in the Arabian Peninsula, the Louvre, Abu Dhabi has deployed artificial intelligence to enhance its operations.

2. Problem Statement

For a long time, museums and cultural heritage spaces were regarded as symbols of continuity that are expected to retain their historic roles and qualities even in the face of new technologies that define the contemporary world. Indeed, according to 2021 Museum Innovation Barometer, less than 20% of museums across the world reported the use of AI in their operations (Tykhonova and Widmann, 2021). However, the lockdowns occasioned by the Covid 19 pandemic in 2020 changed this notion. A 2021 report by the Museums Innovation Centre notes that the pandemic accelerated the production and use of digital content as well as prompted museums to implement digital solutions to manage their collections and stay connected to their audiences (Pasikowska and Lim, 2023). Granted, extant literature is replete with many studies on the adoption of new technologies in museums. However, these studies are confined to museums in Europe, the Americas and Australia with limited focus on Asia, and particularly the Middle East. Indeed, Hufschmidt (2023) survey on the use of AI in museums across the world provided very scanty information on the adoption of AI in museums in the Middle East and particularly in the United Arab Emirates (UAE). This study seeks to fill this research gap by assessing the AI tools implemented by the largest museum in the Arabian Peninsula, the Louvre Abu Dhabi.

3. Research questions

The study will be guided by the following research questions:

1. What are the various Artificial Intelligence (AI) tools that can be implemented in museums?

2. In what ways can the identified AI tools be leveraged to enhance services in the museums?

3. To what extent have the identified AI tools been deployed at the Louvre Museum, Abu Dhabi?

4. What recommendations can be made to optimize the adoption of AI in Museums?

4. Literature Review

4.1.   AI tools that can be implemented in a museum

The first step towards knowing the AI tools applicable in museums setting is having a clear definition of the concept of artificial intelligence. In this regard, several scholars and institutions have attempted to define the term artificial intelligence. These include among others European Parliament (Ciucci & Gouardères, 2020), UNESCO (2021), and the German Ethics council (2023).

As to whether there exists a conclusive definition of the term artificial intelligence, Thiel (2023) argues that the field of artificial intelligence is broad and consists of many different approaches and technological solutions thus navigating it can be confusing. Furthermore, she notes that it is difficult to find a working definition of artificial intelligence given that it is a moving target due

Kabata, Victor
Assistant Professor, Sorbonne University Abu Dhabi

to disruptive technological and economic developments. Likewise, the German Ethics council also noted that the term AI does not have a clear, simple definition and its meaning has changed over the years (Deutscher Ethikrat, 2023).

Currently, the Organization for Economic Cooperation and Development (OECD) definition of the term AI is considered broad enough and has been accepted across the scientific, business and policy communities. Specifically, OECD defines an AI system as a machine-based system capable of making predictions, recommendations or decisions about real or virtual environments for specific goals defined by human beings and operates with some varying degree of autonomy (OECD, 2019).

On the other hand, the European Commission vaguely defines AI as a collection of technologies that combine data, algorithms and computing power (European Commission, 2020).

For purposes of this study, the most appropriate definition of AI is by Amato et al (2019) who defined AI as a set of technologies able to identify complex structures from massive datasets and to use these structures to make predictions and or take actions and decisions on previously unseen data. This approach is known as machine learning (ML) or statistical learning where the computational system learns from data and generalises to unseen data.

Amato et al (2019) definition of AI is relevant to this study as it captures the aspect of machine learning which is considered as the core of AI in the cultural and creative sectors. Essentially, machine learning is a set of algorithms that learn to generalise from data, observations and interactions with the world, all without being explicitly programmed. This then allows the algorithms to make a prediction about something in the world, or to generate new, data based on what they have seen. Machine learning is normally used as an umbrella term to describe a variety of algorithms including neural networks and deep learning. In a museum context, it is applied together or as part of machine vision or natural language processing techniques (Murphy and Villaespesa, 2020).

4.2. Leveraging AI tools to enhance museum services

An appropriate approach to answer research question 2 of this study would be to first identify the various operations within a museum. An understanding of the operations of a museum will make it easier to enumerate the work processes within a museum and the AI tools that are relevant to museum operations.

The role of a museum is very elaborate from the International Council of Museums (ICOM) definition of a museum. The Council defines a museum as a not-for-profit permanent institution in the service of society that researches, collects, conserves, interprets and exhibits tangible and intangible heritage (Pasikowska and Lim, 2023). Accordingly, from this definition it is evident that a museum is expected to undertake research, collect and conserve cultural materials and exhibit cultural heritage. Furthermore, a survey carried out on the public on behalf of the United Kingdom (UK) Association of museums in 2013 identified the essential roles of museums as:

- Care and preservation of heritage;

- Holding collections and mounting displays;

- Creating knowledge for and about society (Britain Thinks, 2013).

Kabata, Victor
Assistant Professor, Sorbonne University Abu Dhabi

Besides the common roles articulated by the International Council of Museums (ICOM) and the (UK) Association of museums, there are additional non-core roles that museums are expected to undertake. For instance, Hufschmidt (2023) noted that the main operations within a museum include, database management, collection tagging, facility management, security and surveillance, PR work, marketing, and presentation strategies.

Having comprehensively understood the roles of museums, it is easy to identify specific activities or work processes where AI tools can be applied. French and Villaespesa (2019) identified three key areas where AI is applicable in museums. These are computer vision for collections information, machine learning for visitor data and voice assistants for customer enquiries.

Additionally, French and Villaespesa (2019) noted that AI should be targeted to the roles within the museum that involve data analysis. These are collection information management and visitor research and evaluation. Specifically, in collection management, French and Villaespesa (2019) noted that AI enhances the collection of data with techniques to clean it up, discover new information, create relationships among data sets or generate classifications and tags automatically.

On the other hand, in visitors research, French and Villaespesa (2019) noted that AI should leverage visitors data from ticket purchases, membership subscriptions and web analytics. In essence, AI techniques should be applied to explore, examine and draw conclusions on museum data to enrich the visitors experience.

A survey conducted in the winter of 2022-2023 by students of the master's program in Expanded Museum Studies at the University of Applied Arts in Vienna also sheds light on areas where AI can be deployed in museums. Specifically, the survey sought to map out the use of AI in museums globally by exploring different areas of application of AI in museum work processes and contexts including collection management, exhibition planning, research, conservation, networking, facility management, visitor service and experience (Hufschmidt, 2023).

5. Findings

In terms of which AI tools can be adapted in the museum sector, extant literature revealed that museums across the world are leveraging different AI tools to enhance their processes as well as facilitate access to their collections. Below is a discussion of some of the AI tools and a description of their application in museum settings.

5.1. AI tools implemented in museums

5.1.1. Chatbot

Murphy and Villaepesa (2020) describe a chatbot as a computer program that is designed to mimic a human interaction in a text-based conversation. Chatbots provide an avenue for engaging with visitors on social media even when the museum is physically closed. In terms of their applicability in enhancing museums operations, Thiel (2023) noted that Chatbot interactions have the potential to enhance the visitor experience through personalized guidance and interaction and providing access regardless of location or person. They offer direct answers to questions, explain works of art, share interesting stories, and help with navigation. Notably, different museums have adapted chatbots for various purposes. For

example, the Anne Frank House Museum uses a chatbot to answer common visitor questions about visiting (Murphy and Villaespesa (2020).

5.1.2. Machine Vision

Murphy and Villaespesa (2020) define machine vision as technologies that extract insights from visual input such as images and videos. It analyses individual pixels and the features that are derived from them, identifying patterns in their variations. They include object and facial recognition. Rani et al (2023) describes facial recognition as a form of technology that uses computer vision algorithms to detect and identify people based on facial characteristics such as age, gender, ethnicity among other demographics. In museum context, facial recognition can be used to detect the age, gender and demographic traits of a visitor. This data is then used to tailor the museum's artwork and tours to a specific demographic of visitors. Further, facial recognition may also be used to enhance security within the museum as well as analysing visitors metrics and preferences (Rani et al, 2023).

5.1.3. Machine learning

As mentioned earlier, one of the most used AI technologies in the museum sector is machine learning. Machine Learning refers to algorithms that learn to generalise from data, observations and interactions with the world, all without being explicitly programmed. This then allows the algorithms to make a prediction about something in the world, or to generate new, data based on what they have seen (Murphy and Villaepesa, 2020). Further, machine learning can be used to generate more accurate models for predicting the implications of certain policies and decisions. This information can be used to enable the museum to better plan (Rani et al 2023). As such, machine learning is frequently applied together or as part of machine vision or natural language processing techniques. For example, at the Norwegian museum, machine learning technologies were applied to museum collections to give visitors easier access through better metadata and explorative interfaces (Murphy and Villaespesa, 2020).

5.1.4. Natural Language Processing

Rani et al (2023) describes Natural language processing (NLP) as the ability of computers to read, decipher, understand and generate human languages. NLP techniques rely on machine learning. Essentially, NLPs can be used to classify content, translation, analyse sentiments and voice recognition by converting voice into written text. In museum context, NLPs can be used to understand visitor's inquiries and respond with automated responses. As such, through NLPs, museums enhance visitors experience through analysing visitors messages, identifying key customer requests and generating responses that are tailored towards customer's needs (Rani et al (2023). For example, the Museum of Science in Boston uses two virtual educators, that is, Ada and Grace to answer visitors questions and provide information on various exhibits (Murphy and Villaespesa, 2020).

5.1.5. Predictive analytics

Predictive analytics is a branch of data analytics that is used to predict future outcomes based on current data (Rani et al, 2023). Similarly, Murphy and Villaepesa (2020) noted that predictive analytics uses a variety of techniques such as data mining, modelling, statistics and machine learning to generate future insights based on data analysis. In museums settings, predictive analytics is normally used for visitor experience management. For example, a dataset of

Kabata, Victor
Assistant Professor, Sorbonne University Abu Dhabi

museum visitors can be subjected to predictive analytics systems to estimate visitor numbers for an exhibition on a particular future date.

5.1.6. Robotic assistants and interactive displays

Robotic assistants are basically machines that can undertake routine human tasks automatically. For example, robotic assistants can be used in museums to assist visitors to locate certain exhibits. On the other hand, interactive displays such as touch screens allow visitors to interact with digital content in more natural ways (Rani et al, 2023). For example, the Smithsonian included the humanoid robot pepper in the National Museum of African- American history and culture where it dealt with visitors queries and told stories using gesture, voce and interactive touch screen (Murphy and Villaepesa (2020). Additionally, robots are also used to enable the physically handicapped to access museum services. Essentially, the museum will allocate a robot to visitors with physical disability, the visitors are then able to experience the museum offerings from the comfort of their homes by controlling the robot and using it as a guide to access the museum services.

5.1.7. Object recognition

It refers to a set of computer vision techniques that can identify an object in videos or images. As such, this technology is used for identifying the location of objects in an image and classification of the objects (Murphy and Villaepesa (2020). In essence, AI object recognition software is used in museum's collection management to authenticate artwork by detecting patterns or features that are not visible to the naked eye, this allows for improved accuracy when verifying the artwork (Rani et al, 2023). Essentially, machines can extract individual elements from the digital object records with a speed that would take humans ages to generate. For example, running an algorithm on collection data enables data visualisations of all object dimensions as well as the identification of faces. This enables curatorial staff to analyse, research and describe museum collections in unique ways (French and Villaespesa (2019).

Notably, this technology has been deployed in different museums. For example, the Cleveland Museum of Art is using AI object detection software to catalogue and track artwork in their collections. The software has a high-resolution camera that captures images of the artwork and then uses algorithms to detect individual objects such as paintings, sculptures, or artefacts (Rani et al, 2023).

5.2. Application of AI at the Louvre Museum, Abu Dhabi

Having discussed the AI tools that are applicable in museum settings and the work processes and operations within a museum where AI is applicable, below is a discussion of the AI tools that have been implemented at the Louvre Museum, Abu Dhabi. Additionally, I will also highlight the specific areas of operations where these tools have been implemented.

Application of AI technologies at the Louvre Museum, Abu Dhabi started at the initial stage of its design. During the construction stage of the Museum computational design technologies were used to enhance the accuracy of the design and construction processes.

Further, augmented reality which uses machine learning was utilized to visualize how the Louvre Museums, Abu Dhabi's intricate dome would fit into the surrounding environment.

Additionally, the Louvre Museum Abu Dhabi leverages AI's natural language processing and interactive displays in several ways. First, the Louvre App has a feature known as *Art Scan*

Kabata, Victor
Assistant Professor, Sorbonne University Abu Dhabi

that allows visitors to get the content of the artwork of their choice directly on their screen in selected languages. Further, the App has an interactive map that helps visitors find their way through galleries (Louvre Abu Dhabi, 2025). As such the interactive map utilises touch screen capabilities that allow visitors to the Louvre to interact with digital content.

Louvre Museum, Abu Dhabi has also leveraged natural language processing to create AI generated content. This content is fed into a chatbot that explains to visitors the history behind certain artefacts, the artists who created the artifacts and other details. This has created a new level of interactivity and engagement with the museum visitors (Louvre, Abu Dhabi, 2020).

Furthermore, Louvre, Abu Dhabi has used AI to create an interactive exhibit known as "*Artificial Intelligence and Intuition".* The exhibit uses sentimental analysis to analyse visitors' movements and emotions and responds with a customized audio and visual experience. This sentimental analysis enables the Louvre to determine and understand the attitude of its visitors towards a certain artwork or exhibition and come up with measures to enhance customer experience.

The application of AI was also evident during a recent international exhibition hosted by the Louvre Abu Dhabi in 2024, that was dubbed 'From Kalila wa Dimna to La Fontaine :Travelling through fables'. Specifically, visitors were invited to select their own story using French, English or Arabic. By selecting a writing style from those of the authors discovered in the exhibition, and choosing characters and a moral, a personalised fable based on the criteria selected was then generated through AI. As such, by creating personalised fables, visitors can immerse themselves in a fascinating world, while putting into practice the knowledge they have gathered in the exhibition. In selecting the characters, style and moral of their story, they explore the nuances of the literary genre and leave with a tangible memory of their visit (France Museums, 2024).

Additionally, just recently, Louvre Abu Dhabi launched a machine translation project in collaboration with Sorbonne University Center for Artificial Intelligence (SCAI). The project seeks to train a machine translation model tailored to the needs of museums. The project will apply AI to automatically extract terms from Louvre Abu Dhabi's digital collections.

In sum, the study revealed that the Louvre, Abu Dhabi is still at nascent stages of implementing AI technologies to enhance its operations. Indeed, this was confirmed by a representative of the museum who noted that "We are aware that the contemporary museum user is digital savvy, and we are gradually adopting different AI technologies to enhance our operations".

6. Research Methodology

The study adopted a qualitative research approach and a case study research design. The Louvre Museum Abu Dhabi is the main case. Data was collected through literature review-Louvre Museum Website, Journal articles and books on application of AI in Museums. Semi structured Interviews were conducted with purposively selected respondents. In particular, the researcher interviewed one of the staff at Louvre Museum Abu Dhabi to provide additional information on the application of AI technologies. Data was analysed thematically based on the research questions of the study.

Kabata, Victor
Assistant Professor, Sorbonne University Abu Dhabi

7. Conclusion and Recommendations

The study has revealed that the opportunities offered by AI to museums and cultural heritage institutions are immense. Indeed, deployment of AI technologies promises to revolutionize museum operations by enhancing collections management, improving user's satisfaction and visitors management. However, implementation of AI in museums poses several challenges. According to a study by the Directorate General for Communications Networks, Content and Technology of the European Commission (2022), the challenges facing the museum sector include lack of skills and knowledge necessary for adoption of new technologies as well as internal biases within AI systems. Further, AI projects are capital-intensive nature yet there are limited funds available to many museums across the world. To address these challenges, the study recommends that AI projects in museums should be strategic and implemented in a robust manner to ensure viability. Additionally, adoption of AI in museums raises ethical questions such as privacy and algorithmic bias. To solve these ethical concerns, Boiano et al (2024) emphasise on the need for ethical frameworks. They argue that such frameworks aid in the equitable and responsible adoption of technology and new forms of participation which can extend the role of museums as social good agents. Overall, the study recommends that AI projects in museums should be guided by the AI Museums Planning Toolkit that was developed by Murphy and Villaespesa in 2020. The tool kit proposes a capabilities framework that outlines elements that should constitute AI project implementation in museums. These elements include data, tools, resources, skills, organisation and stakeholders. Anchoring the implementation of AI projects on the Museum Capabilities framework will ensure that AI projects are strategic, ethical and robust thus ensuring a sustainable digital museum experience.

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Kabata, Victor
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