International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878, Volume-8 Issue-5, January 2020

The Application of Artificial Intelligence Technology in Cultural Heritage Development

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Abstract: ***Technological development is having a vital impact on our societies. In recent years, we have seen a remarkable increase in smartphone users in countries with developing economies such as Jordan. This research aims to explore and develop opportunities for supporting cultural heritage in Jordan using emergent technologies. A study was conducted to understand the challenges and obstacles for developing cultural heritage and cultural heritage sites, and to study the new emergent technologies and explore the benefits that can protect and promote cultural heritage in Jordan. Based on the study, an AI solution was designed and prototyped to address how emerging technologies can be used to improve the delivery of tourism services and the visitor experience. This research demonstrates how technology would ensure sustainable economic growth and shows the interrelations between cultural heritage, technology, services, and their impact on the local community.***

Keywords: Emerging Technologies, Artificial Intelligence, Smart Phones, Cultural Heritage, Tourism, Jordan

I. INTRODUCTION

while we see the rapid use and development of new digital services on a daily basis, the opportunities for promoting and protecting cultural heritage are still not sufficiently developed. In the next 30 years, most tourists will be digitally native, and thus, the interaction with cultural heritage might not remain excited as it was before. This drives a need to consider the embodiment of emergent digital technologies to augment cultural heritage locations and offer more intelligent and exciting interactions to visitors.

In recent years, we have seen a remarkable increase in smartphone users and this increase is also true for countries with developing economies (e.g. Jordan). The typical smartphone contains several sensors and inputs (GPS, camera, microphone, steps counter), while some contain features for biometrics, temperature, light sensing and distance from the ground. All of these capabilities, besides data collected from various sources, have offered a foundation for developing innovative mobile apps. Moreover, the development in information technologies is showing that the technology costs are reduced remarkably – raspberry Pi computers can cost as low as $5, for example, while naked sensors cost a fraction of that price. Shortly, the 4G telecom networks will be replaced by 5G networks, which are much faster and more reliable. The opportunities created by such circumstances are numerous. Jordan has around 12 locations that experience high demand from local, regional and international visitors, and demand for cultural heritage tourism in Jordan is high. Nevertheless, few of the Jordanian cultural heritage locations are adopting technologies.

Consequently, it is difficult to determine the level of support, amount of investment, and skills needed and what the visitor experience could be. Without technology involvement, the collection and integration of useful information will be a massive challenge, involving a massive investment of resources and time. The research aim is to enhance the visitor experience, improve the documenting of cultural heritage, and develop local businesses and the country's economy. In our research, we would like to examine the factors that might affect the development of an integrated cultural heritage ecosystem, which will integrate locations, cultural heritage artefacts, people, and economies through technology deployment.

II. BACKGROUND

Over the most recent two decades, countries around the globe have become mindful that the travel industry requires a protected and secure condition in which to flourish. The aftermath of the assaults against the United States on 11 September 2001 reverberated around the world. These shockwaves were perhaps most keenly felt in the global travel industry. In this context, the diary *Rejuvenate* detailed the following concerning post 9/11 travel: "America passed up 78 million inbound voyagers and $606 billion on account of September 11, as indicated by financial information given by the U.S. Travel Association. In a discourse with the media, Roger Dow, president and CEO of the USTA (US Travel Association), tended to the effect of the fear-based oppressor assaults on movement amid the most recent decade and offered standards to help reinforce security and dispose of hindrances that are demoralizing travel to and inside the United States".

The lost income and tourists, based on the expected pace of development of worldwide long-haul travel in the decade after 9/11, would have bolstered US employment with 467,000 new jobs every year. Dow likewise demonstrated that the US piece of the worldwide travel industry pie dropped from 17 per cent in 2000 to 12.4 per cent in 2010, during a period in which worldwide travel grew by 40 per cent [1]. Business travel declined 21 per cent (because of both 9/11 and the various emergencies of the late 2000s), yet began to rise again in 2010, expanding by almost four per cent, and development was healthy through to 2014.

Manuscript published on January 30, 2020.
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Recreational travel volume has expanded by 17 per cent since 2000, despite a couple of long periods of adverse development; however, the overall development was healthy through to 2014. The chart beneath likewise delineates this point. The diagram shows the plunge in the world travel industry due to the 9/11 factor of fear [1].

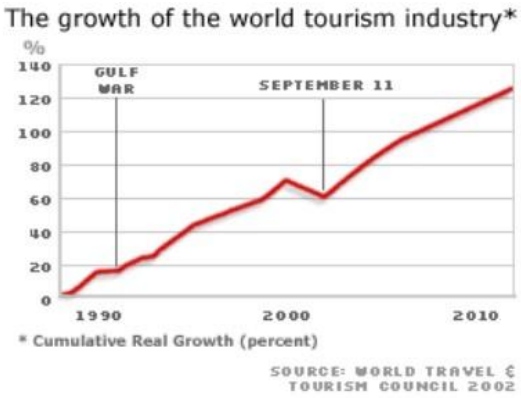

Fig. 1: The growth of the world tourism industry [1]

A. Tourism in Jordan

According to stakeholders, the tourism sector was expected to still recover in 2018, urging the bodies concerned to make more efforts to plug the dominion better and open up new markets. Jordan Tourism Board (JTB) Director Abed Al Razzaq Arabiyat said that 2017 saw a "significant" increase within the amount of tourists, according to figures from the Jordanian financial organization. Arabiyat said, in November 2017, that tourism revenues had risen by 14.3 per cent compared to the same period in 2016. He presented several measures that helped to reinforce tourism indicators, including cooperation within the promotion fields with the relevant bodies. The JTB also backed proposals to reinforce charter and low-cost airlines, including ticket prices. Bookings for trips to Jordan in 2018 were "promising," with fewer cancelations compared to previous trips [2]. `In 2011, Jordan had 1,300 tourist guides who spoke 39 languages; at the present , the amount has dropped to 1,000 as many guides left the work thanks to low demand or age, according to Ababneh. "Tourism is now growing and therefore the industry needs more guides, particularly those that speak far-eastern languages like Chinese and Indonesian," Ababneh said, calling for more guides to be qualified to meet demand. Ababneh stated that the JTB had agreed to set official guidance fees per day at JD60 with the appropriate bodies. Tourism Minister Lina Annab said, in recent remarks to The Jordan Times, that tourism figures were above expected in 2017, adding that this year's figures will still rise. Figures from the World Trade Organization showed a four per cent drop by the amount of tourists within the region in 2017, but instead, Jordan witnessed a hike, the minister said. the amount of overnight tourists increased by 9.5 per cent until the top of November, reaching 3,911 million visitors, compared with 3,574 million in an equivalent period last year, the ministry's figures showed.

Meanwhile, within the first 11 months of this year, the number of one-day visitors increased by 6.4 per cent compared to an equivalent period in 2016 [2].

B. *Technology's role in tourism*

Technology has contributed to the massive economic growth of tourism in several ways (see Table 1). The applications of technology have offered time and methods for people to travel and have contributed to overall economic growth [3].

Table 1: Technology's role in tourism [3]

Technology's role in tourism:
Technology's contribution to tourism growth
Technology as creator of the tourism experience
Technology as protector of the tourism experience
Technology as enhancer of the tourism experience
Technology as focal point of the tourism experience
Technology as tool of the tourism industry
Technology as destroyer of the tourism experience

As data and correspondence advances progressively enter our lives, society and the economy are adjusting to the flood of advancement that is related to this change. The improvement and utilisation of organised innovations (for example, the Internet) will leave no industry unaffected, but will perhaps impact more significantly on the travel industry than on some others. The travel industry and innovation, being two of the biggest, most quickly developing and generally unique enterprises, have turned out to be inseparably connected, and together they are changing how society works.

Buhalis claims that understanding the capability of the Internet gives the travel industry firms of all sizes the chance to receive new promotional models and distribute an expansive scope of advertising content. Notwithstanding the extraordinary data nature of the travel industry item, small firms are not capable of showcasing themselves on the web. In the neighbourliness business, promoting and publicising items, also as social affairs showcase insight, has been dominated by more prominent organisations and chains. One potential answer to this issue could be that little cordiality firms receive alliance and agreeable practices. Customarily, such participation has been limited to the generation of joint showcasing pamphlets and shared stands at public expos. The approach of the Internet offers extended open doors for helpful showcasing and, to date, the greatest enthusiasm for utilising information and communication technology (ICT) arrangements in the travel industry segment has been to create shared web-based showcasing activities. Be that as it may, an eminent travel industry-specific investigation into the helpful utilisation of the Internet as an advertising apparatus is still in its early stages. Information on the course of customers' enquiries and primary leadership forms as to discovering goals online are similarly rare [4].

The examinations were like the exploration of web-based business, in that customers received online apparatuses to take part in web-based business in the travel industry, which extended the travel industry channel. Therefore, it improved the competency of the travel industry firms. Along these lines, the travel client's use design began to change and firms' reaction designs, including innovation arrangements, likewise changed. Subsequently, a survey of the e-travel industry fixated on the PC-based Internet is fundamental in recognising the connection between versatile innovation and the travel industry, since it considers changes in customer use examples and firms' mechanical reaction designs. Utilising research on buyers' utilisation of the Internet for arranging

travel from the fulfilment viewpoints, [6] recognised that most explorers completely adjusted to such arranging through the Internet. They brought up that long-range informal communication destinations and video sharing are becoming more famous for excursion arranging, that the PC is being utilised less, much of the time, and that tablet PCs and GPS are being utilised as often as possible. Different classification strategies exist for mobile technology innovation as an empowering influence and essential factor of the travel industry.

Portable innovation can be a delegated foundation that gathers and conveys information – for example, a system, a sensor, a chip and IoT – or it tends to be delegated innovation that combines analyses and streamlines data. On the other hand, it may be named as a platform service, for example, applications, the cloud, and open API [7].

Also, portable innovation is a broad idea, and it tends to be ordered into four categories. The primary class is innovation, identified with information accumulation, analysis, and communication. This classification incorporates seeking advances, sensors that gather the information that emerges from common associations among vacationers and the Earth, and short-go remote correspondence advances, for example, RFID and NFC [8].

At the point when clients create data utilising geotags containing area information, technology to recover the information from the geotag and to channel them is essential. Additionally, the technology that recovers client profiles and incorporates other data is also important [9].

The technology identified with information incorporates new strategies for information gathering, information investigation, information trade, information sharing, and correspondence [10]. Creating logical information calculations for the travel industry is likewise fundamental, although not canvassed altogether in the travel industry look into [11]. Recently, endeavours have been made to examine a goal's picture from data quality, which demonstrates that information representation is likewise turning into a concentration in this field [12]. In the travel industry, innovation must combine information and data, and support ubiquitous networks and ongoing synchronisation to make new experiences for clients [13].

C. Machine learning

Artificial intelligence, machine learning and deep learning are the technologies the world is heading towards [14]. These techniques bring the computer closer to the human mind. The computer learns to classify tasks directly from images, text or sound.

Machine learning (ML) is a core sub-area of artificial intelligence that allows computers to get a self-learning approach without being coded. It focuses on making machines imitate human functions. Machine learning breaks the convention and works by recognising patterns and developing its algorithms even if the data changes. Some of the problems that were solved by using ML are: Classification, Ranking, Sequence Prediction, and Similarity Identification. Machine learning can be implemented using high-level languages like Python, which has built-in features for mathematical matrices [15].

Deep learning is a massive breakthrough in machine learning, and it has been going into many improvements in many fields such as natural language processing (NLP) and speech and image recognition. Deep learning uses neural networks as a visualisation technique, which is why deep learning models are often referred to as deep neural networks [16].

Neural networks are part of ML techniques. These networks are not designed to imitate the realistic models of the brain but rather provide data structures and stable algorithms that can solve severe problems. Neural networks have units called 'neurons' placed in layers. The types of layer used in a network can be divided into: input layers, hidden layers and output layers; the neural networks can be called shallow (with one hidden layer) or deep (more hidden layers) networks. These types of networks are trained to be able to read inputs as features, optimally in different resolutions and scales, and should then be able to make predictions. Furthermore, neural networks can be divided into three main types: artificial neural networks (ANN), convolution neural networks (CNN) and recurrent neural networks (RNN) [17].

D. Convolution neural network model and improvement

As described by [18], one of the major attractions in recent years has been the introduction and improvement of CNN, presented as a highly efficient identification methodology. Nowadays, CNNs are considered a go-to technique in many research and application fields. In a convolution neural network, the advantages of having multiple models with different shared structures and the ability to reading multiple input data in parallel made it superior to other methodologies in speech and image recognition. This simplified the feature extraction and classification process, making CNNs more widely used.

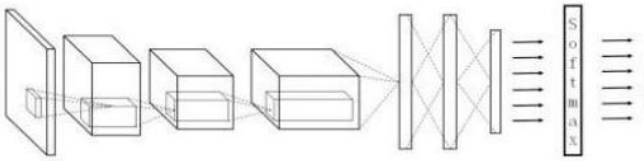

Fig. 2: A convolutional neural network created for image classification [18]

Figure 2 shows the standard structure for a convolution neural network created for image classification. As seen in the figure, a CNN is primarily composed of five types of layers: an input layer, a convolution layer, a pooling layer, fully-connected layers and a Softmax (classification) layer. The input layer is responsible for reading the data inputted into the network. The convolution layer is the main part of a convolutional neural network, and is made up of multiple neurons (nodes) distributed as a matrix, each node being responsible for scanning a small part of the input of the layer for any significant features.

The convolution layer analyses the input to get a higher level of feature abstraction. The pooling layer is used to reduce the size of the matrix without changing the depth of the matrix inputted to the network, but by reducing the matrix size it will reduce the number of nodes outputted to the next layer. This will reduce the number of parameters processed by the network and will therefore decrease the overall training time.

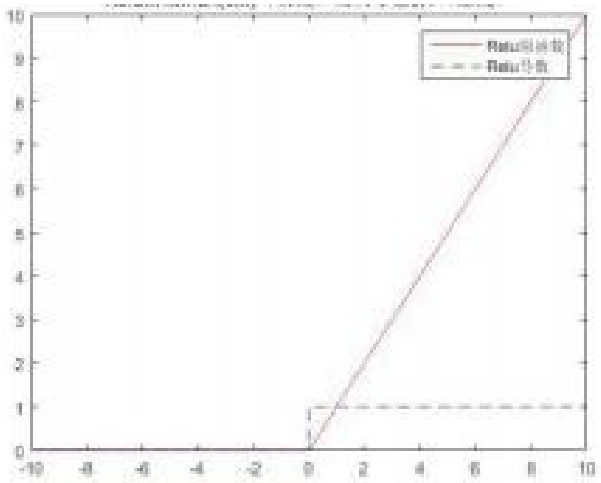

Fig. 3: ReLU function and its derivative image [18]

In Figure 3, it can be seen how the ReLU is hard saturated at $x < 0$. As when $x > 0$, the derivative is 1, ReLU is able to maintain the gradient without attenuation when s, consequently successfully alleviating the gradient disappearance problem. Nonetheless, activation neurons of the ReLU are fragile, so in the training process, part of the input falls into the hard saturation area; this will lead to irreversible neuronal death, and the equivalent weight cannot be updated.

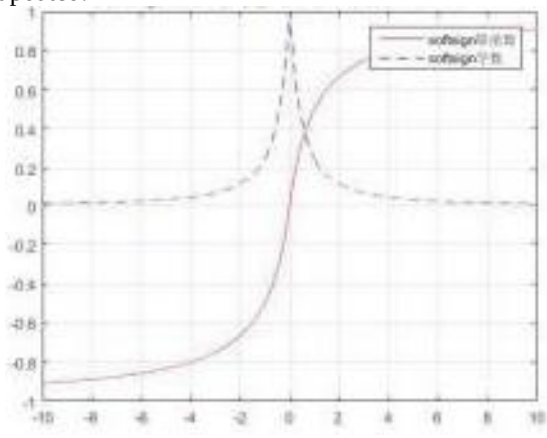

Fig. 4: Softsign function and its derivative image [18]

Figure 4 explains how the Softsign function compresses the data into the interval of (-1,1). The output is centred on 0, though since its asymptote line is smoother, saturation slowly approaches 0, the range is relatively wide, and thus the initialisation process is more robust. the middle a neighbourhood of the Softsign function is wide, and thus the world on the brink of $x = 0$ is reduced, the degree of non-linearization is high, and it's easier to delineate the more complicated boundary.

III. THE PROPOSED TOURISM SYSTEM

The system consists of an Android application, which works as a front end, and a CNN model that works as a back end. The architecture of the system depends on different tiers. At first, we have the front end consisting of four main layers as the following:

- Activities
- Services
- Broadcast receivers
- Content providers

Additionally, the web site is connected to the firebase database, where only the content provider can communicate with the DB. Moreover, we've an application API (activities) that gives services for mobile applications through providing a communication to the database of the system (see Fig. 5).

The technologies that are utilized in in our project are described as follows: At first, we've the MVC framework, which stands for Model View Controller, where the view contains all commands that are associated with the interface. Additionally, to all or any the logic needed to rearrange the info showed the user, the model consists of all the info that we would like to display to the user; we don't need to return all the components to the user, so therefore it gives the power to regulate all we would like to display.

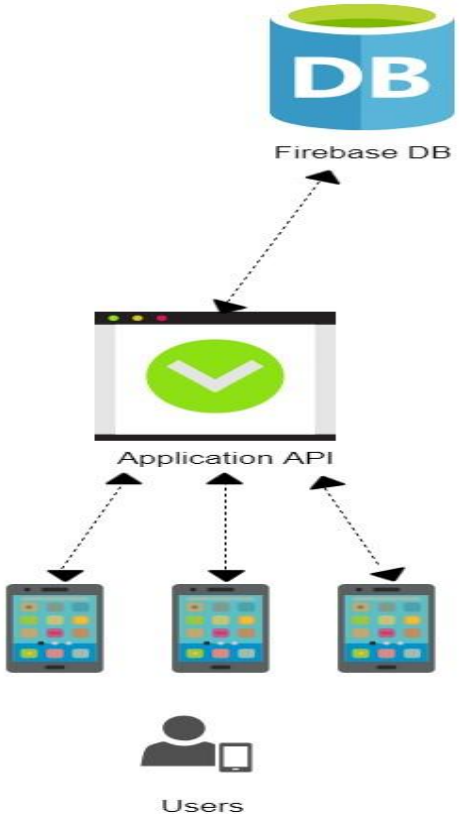

Fig. 5: System architecture

Using the Android studio, we were able to build our application efficiently with a simple use interface.

We have worked with Firebase Authentication, which helped us outsource our entire authentication system to Firebase so as that we could consider building great features for our app.

Firebase Authentication makes it easier to urge users to see in without having to understand the complexities behind implementing our own authentication system. It offers a simple 'getting started' experience, optional UX components designed to minimise user friction, and is formed on open standards and backed by Google infrastructure. This makes the application safer. The SDK tools helped us in connecting the Firebase with the Android studio.

Secondly, regarding the CNN model, which worked in our application as a back-end, we have developed a Keras model that serves the application's main function, which is the image search property.

The CNN model was built using two Python libraries (Keras and Tensorflow). The model consists of two main components, which are the data pre-processing and the fully connected ANN.

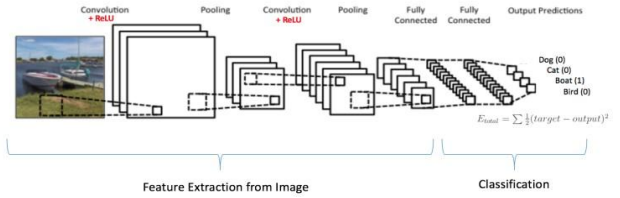

Fig. 6: CNN components diagram

The data pre-processing contains two convolutional layers, two pooling layers, and one flattening layer. These layers were constructed and ordered as follows:

First, there is the first convolutional layer, which was ordered using the Conv2D class imported from Keras. It will receive coloured images of size 64x64 and produce 32 feature maps using a 3x3 convolution filter and the 'ReLU' activation function, which is used to increase non-linearity.

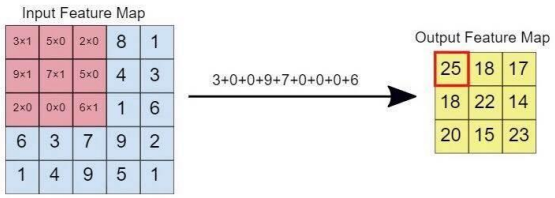

Fig. 7: Convolution layer

Second, there is the pooling layer, which was ordered using the MaxPooling2D class imported from Keras. It will receive the featured maps produced from the previous convolution layer and perform the max pooling function, which is used by a 2x2 matrix. The first pooling layer is then followed by the same steps as before (convolution and pooling).

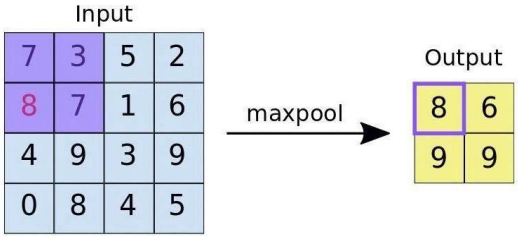

Fig. 8: Pooling layer

Finally, there is the last layer of the data pre-processing flattening, which takes each pooled map and flattens it into one vector that contains all of the pooled maps produced previously.

The flattening layer serves as an input layer for the fully connected ANN.

Fig. 9: Flattening layer

Then, there is the ANN, which has three layers (without the input layer). The first two layers serve as hidden layers, each consisting of 64 neurons. The ANN was constructed using the Dense class that was imported from Keras. Both hidden layers used the ReLU activation function. The output layer contains ten neurons, which is the number of classes used, and used the Softmax activation function.

The model is compiled with the optimiser as the 'adam' algorithm, with 'categorical_crossentropy' as the loss function, and 'accuracy' as the only metrics for the model, and is later trained using the 'fit_generator' function with a batch size of 32 and 40 epochs to reach the accuracy of 70 per cent.

We have used 300 images referring to ten classes to train the model, with 40 images that refer to these classes as a test set.

IV. RESULT AND DISCUSSION

As mentioned earlier, a study was conducted to understand the challenges and obstacles for developing cultural heritage and cultural heritage sites, and to study the new emergent technologies and explore the benefits that can protect and promote cultural heritage in Jordan. The study was done through a questionnaire presented for local, regional and international tourists, which aimed at studying the importance and interest in a smart application that would help guide the tourists in major tourism attractions.

The questionnaire results can be seen in Figures 10 to 14, and can be described as follows: 269 people have answered the questionnaire, 62 per cent said they visit a tourism site once a year while 21 per cent answered "two to four times". Answering the question "What is the main difficulty that could face a tourist in Jordan?" around 51 per cent answered by stating "a lack of knowledge of places to visit." Ninety-four per cent thought that having a smart guide application would benefit tourism in Jordan, while around 83 per cent said they would use an application instead of a tour guide.

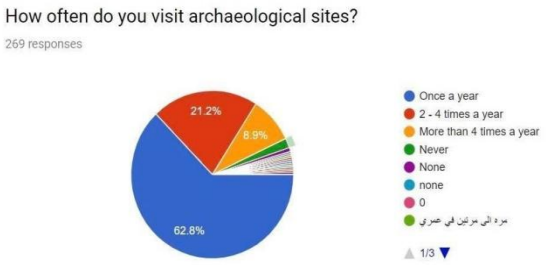

Fig. 10: Questionnaire analysis

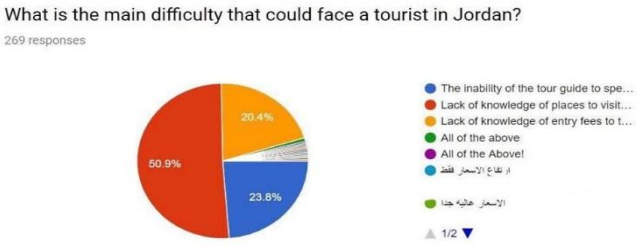

Fig. 11: Questionnaire analysis

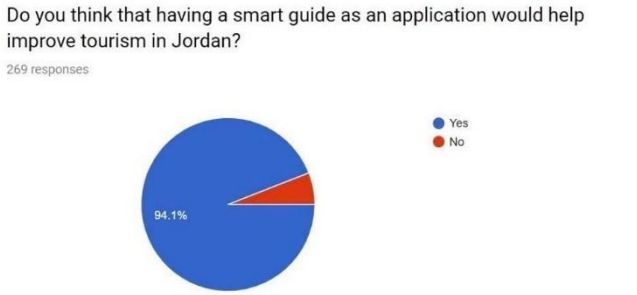

Fig. 12: Questionnaire analysis

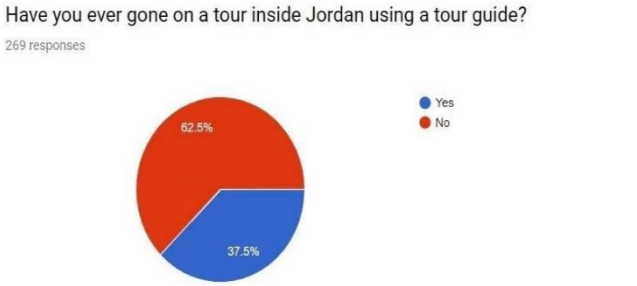

Fig. 13: Questionnaire analysis

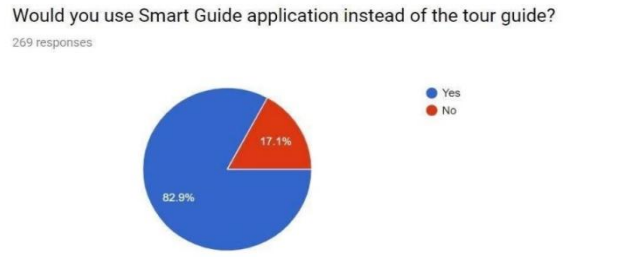

Fig. 14: Questionnaire analysis

The study gave an overview of the likelihood of success of the proposed system to transform Jordanian cultural heritage institutes' ability to digitally protect and promote cultural heritage sites. This will be manifest in a new system to enable knowledge integration, with visitors' experiences posted on social media. The technologies will also enable observing changes in cultural places and services. Public services concerned with cultural heritage sites need to do more to enable technology-based innovation and engage with theprivate sector and the local community.

After seeing the overwhelming interest in a smart guide application, a proposed system was designed, as detailed in section III. It shall be built and made available for tourists in Jordan soon, which will allow more feedback and more studies to be presented in the future.

V. CONCLUSION

In conclusion, tourism, in general, is one of the primary incomes of any country, and this is especially the case in Jordan. So, to improve tourism would have significant impacts on the Jordanian economy. Moreover, people come from different countries in the world to see Jordan's archaeological sites. As a result, any mistake in the information about these places would cause a severe gap in knowledge for visitors, which would lead to them being seen as less valuable than they are. We all use technology nowadays, so the best way to help save the historical places' values is to make them merge into technology.

With the goal of showing the importance of technology in helping tourism, this paper presented a study showing the importance of, and the high interest in, using a 'guiding application' for tourism. Furthermore, this paper presented a proposed structure for a system that can be deployed as a guiding system enforcing the latest technological trends such as deep learning.

The developed system will play a significant role in integrating cultural heritage knowledge in Jordan with visitors from other countries toward a universal and unified cultural heritage platform.

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