Significant Islamic Cultural Attractions of Tourism in Cirebon Revealed through Neuroscience.

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Abstract

Cirebon is a region rich in Islamic cultural heritage. The Islamic culture in Cirebon traces its origins to the Sultanate of Cirebon, where the ruler, Sunan Gunungjati, a member of the Wali Songo (Nine Saints), spread Islam to the western part of Java. As a result, Islamic cultural activities in Cirebon serve as an attractive force for tourists. However, with the advancement of modern civilization, Cirebon's Islamic culture faces competitions from foreign cultures. As a space shaped by primordial Islamic culture, Cirebon requires efforts to identify the interests of the tourists in this culture.

The research employed a neuroscience approach, specifically measuring the brainwave activities of the tourists using an Electro-Encephalography (EEG) device. The analysis was conducted using MATLAB to process brainwave data of selected tourists in response to visual stimuli depicting cultural attractions in Cirebon. The study involved 14 tourists, and the data collection process included presenting visual stimuli, such as traditional Cirebon dance performances with philosophical narratives. The data acquisition from 14 respondents underwent pre-processing, which involved normalization and filtering using a Butterworth bandpass filter. Afterwards, the signal was cropped and processed with spatial selection and common active channel analysis to measure the EEG responses.

The results showed that the most frequently active channels, indicated focused thinking and interest in the visual stimuli. These findings suggest that increased activities in certain brain regions corresponds to heightened interest in the Islamic cultural attractions in Cirebon. They demonstrate the interest of the tourists in the culture of Cirebon.

Keywords: Neuroscience, Islamic Cultural Tourism, Cirebon, Tourism, Electroencephalography

Introduction

Indonesia boasts a rich tapestry of diverse cultures, each with its own distinct local traditions across the various regions of the country (Nahak, 2019). However, Suryani & Purnama (2018) show that rapid technological advancements have led many young Indonesians

to overlook or abandon their cultural heritage. As Suryani & Purnama (2018) show, this phenomenon has been exacerbated by globalization, which has contributed to a decline in public awareness regarding the importance of preserving the cultural identity of Indonesia. Moreover, Nahak (2019) says that today, the younger generation tends to be more attracted to foreign cultures than to their own local traditions. Revitalizing an understanding of local cultures among the young people is thus essential in safeguarding the cultural heritage of Indonesia.

Agustina (2021) points out that local culture of Cirebon is shaped primarily by the primordial Islamic traditions, with the tourist attractions of the region deeply intertwined with the early spread of Islam in western Java. She says that the historical connection is exemplified by the palaces in Cirebon that still stand as cultural landmarks. Moreover, the tombs of kings and early Islamic propagators serve as significant spiritual tourist destinations. Traditional performing arts, including dance and esoteric cultural performances, continue to be prominent attractions, imparting moral and spiritual teachings of Islam.

The historical and cultural traditions of primordial Islam of Cirebon provide valuable insights into human morality (Agustina, Fauzi & Ekasari, 2022). Preserving this unique heritage is of utmost importance. However, in the contemporary era, cultural promotion can leverage visual technologies that enable people to engage with various cultural practices remotely, without the need to physically visit these locations. The primordial Islamic culture of Cirebon for instance, can be effectively showcased through visual media, such as short films that highlight historical spaces and traditional performances like the Cirebon Mask Dance.

It is noteworthy that Folgado-Fernández et al. (2023) show that the advancements in digital technologies have significantly enhanced tourism promotion. Undeniably, heritage tourism in the Cirebon region requires an elevated promotion strategy that incorporates technology. Among these, one promising technological approach is neuro-evaluation, which examines the impact of cultural tourism on human brain wave activity. In this context, this study examines how the tourists interact with the Islamic culture of Cirebon through a neuroscience framework, specifically utilizing Electroencephalography (EEG).

The objective are as follows.

1. To gain insights into neural responses to cultural stimuli, by means of EEG recordings.
2. To assess the brain wave activities of the tourists to visual stimuli related to Cirebon.
3. To provide a measure of the degree of engagement and the interest of the tourists in the Culture of Cirebon.
4. To stimulate and enhance the interest of the tourist in the Islamic culture of Cirebon.

Theoretical Framework

This research employs a number of theoretical notions that need clarifications. The first among them is Neuroscience. According to the basic definition, it is the study of the nervous system – from structure to function, development to degeneration, in health and in disease. It covers the whole nervous system, with a primary focus on the brain. Thus, employing Neuroscience involves the study of brain activity in response to stimuli.

Different parts of the brain are stimulated by different stimuli in the environment. The left hemisphere includes several brain regions, namely the Frontal Lobe (front), Central Sulcus, Parietal Lobe (top), Occipital Lobe (back), and Temporal Lobe (sides). The Frontal Lobe is associated with high cognitive processes such as thinking, working memory, concentration, and reasoning. The Parietal Lobe is involved in processing sensory information such as touch, temperature, size, shape, and spatial awareness. The Temporal Lobe processes auditory information and memory. the Frontal Lobe is associated with various human capabilities and activities, including intellectual functions such as cognitive processing, sustained concentration, reasoning, and the regulation of emotions and motor control.

On the other hand, the Temporal Lobe is involved in functions related to auditory processing, memory, emotional responses, and visual information processing. Both of these brain areas are critically engaged when respondents are exposed to the visual stimulus, as all emotional responses, cognitive processes, reasoning, and heightened concentration occur during the observation of the stimulus.

These brain activities indeed contribute to the experiences a person has arising from the external stimuli from the surrounding environments. One of the significant aspects of tourism experiences are related to the quality of the heritage objects in the environments which the tourists are coming to experience. In this sense, the concept of authenticity plays a significant role.

In fact, authenticity represents the relational reality between the objective and subjective experiences (Kolar and Zabkar, 2010). The concept of authenticity is socially constructed and involves ongoing negotiation among people, places, and objects (de Andrade-Matos, Richards and Barbosa, 2022), as shown in the Figures 5 and 6. It is argued that the interest of the tourists is strongly linked to authenticity which can be ascertained by means of the brain activities co-related to an external stimuli. This idea has gained momentum in theoretical articulations of neuroscience and can be employed in examining cultural heritage as experienced by the tourists.

Indeed, the theoretical framework of this research is rooted in the intersection of Islamic culture, tourism, and neuroscience. Islamic culture is rich in practices designed to strengthen the relationship with God. Activities such as pilgrimages to sacred sites like Mecca and Medina, meditation through *dhikr* (remembrance of God), and participation in the religious rituals are all designed to evoke profound spiritual experiences. In this regard, Newberg (2015) discusses the practice of *dhikr* in Islam and its impact on the functioning of the human brain. Alqathama and Ahmad (2024) reveal that the practice of Hajj in Islam provides a transformative spiritual experience that influences human behavior. Kannan *et al.* (2022) further explain how the practice of reading the Qur'an influences cognitive functions within the human brain.

Tourism activities viewed through a neuroscience lens enable a clearer understanding of the spiritual experiences Muslim tourists undergo, as these experiences are reflected in the brain wave activities. Notably, Newberg et al. (2015) shows tht Islamic cultural practices, such as pilgrimages and meditation, significantly create brain activities, leading to deep spiritual experiences. In this context, the role of neuroscience is useful in mapping the cognitive and emotional experiences of Muslim tourists, specifically through the interpretation of brain wave patterns. As noted by Lazo, Alfonso and del Vallin (2023), neuroscience-based marketing, which stimulates cognitive and emotional responses, can provide insights into such tourist behavior.

Literature Review

In recent years, neuroscience techniques have gained significant traction in analysing consumer behavior, particularly in fields such as advertising, marketing strategies, and tourism (Li et al., 2022; Oliveira, Guerreiro and Rita, 2022). These tools often integrate theories and methods from disciplines such as economics, psychology, and marketing to provide a comprehensive understanding of consumer decision-making processes (Cardoso *et al.*, 2024). As a result, the convergence of neuroscience, tourism, and hospitality has led to the emergence of a new field called "neuro-tourism" (Al-Nafjan, Aldayel and Kharrat, 2023).

Neuro-tourism employs various neuroscience techniques—such as eye tracking, electro-encephalography, and galvanic skin response—to gain deeper insights into tourist behaviour, experiences, and preferences (Alsharif et al., 2023). By utilizing advanced neurophysiological techniques, such as brain imaging, neuro-tourism seeks to uncover the underlying neural mechanisms that drive the different stages of tourist experiences (Al-Kwifi, 2015; Alzboun *et al.*, 2024). In fact, this multidisciplinary approach offers immense potential to transform the tourism and hospitality industries by providing innovative insights into consumer behaviour and by enhancing the design and delivery of exceptional tourism experiences (Hsu and Chen, 2020; Al-Nafjan, Aldayel and Kharrat, 2023; Alsharif *et al.*, 2023).

Current knowledge has evolved rapidly with the application of neuroscience across various domains, including Islamic Culture and Tourism. The neuroscience approach, specifically the analysis of brain wave activities, has provided fresh perspectives on cultural tourism in Cirebon, addressing the gaps in traditional marketing strategies. Research focusing on the Islamic culture of Cirebon through a neuroscience lens is set to introduce new perspectives to cultural tourism planning, contributing to the development of more effective and insightful tourism strategies in Cirebon.

Research Methods

This is experimental research. In this, data was collected from 14 respondents through visual stimulation in the form of a video film about the Islamic Culture of Cirebon. Raw EEG data was recorded in the European Data Format (EDF), which contains a series of numbers acquired during the brain signal recording. The recording took place in a calm and quiet environment to avoid potential noise during data acquisition. At the start of the recording, respondents were instructed to sit in a relaxed position, ensured that they were well-rested, not stressed or sleepy, and maintain focus on the provided directions. The instructions were related to the recording process to ensure that the data collected accurately represented the desired mental state.

Data was acquired by measuring real-time brain activities using electro encephalography (EEG). The research utilized the KT-88 device with 16 EEG channels, each with different frequencies due to the varying brainwave cycles occurring every second. Brainwave patterns changed each second, depending on the activities. To assess the performance and accuracy of the EEG signal dataset, the Spatial Selection Method (Firdaus, Fauzi and Fuadah, 2020) was employed. This method identifies the area that captures the highest channel activities. Channels showing the highest activities were then selected and combined to form a "common active channel," representing all the respondents.

This method was implemented through EEG signal processing simulations, which were carried out step-by-step using MATLAB R2020a software to achieve the desired system. Electro encephalography (EEG) is a graphic recording of brain electrical activity obtained from electrodes placed on the scalp (Alyasseri *et al.*, 2020). EEG measures the voltage fluctuations produced by the neurons on the surface of the scalp (Jebelli, Hwang and Lee, 2018).

Recordings are obtained using electrodes positioned in various locations on the scalp (Muhammad, Hossain and Kumar, 2021). The electrode placement plays a critical role in capturing ionic current flows on the scalp (Salankar, Mishra and Garg, 2021), which is essential for accurate recordings. Typically, EEG signals are recorded by placing electrodes on the scalp, and the number of electrodes varies depending on the research setup, ranging from 16, 32, 64, to 128 electrodes. The International Federation of Electro-encephalography and Clinical Neurophysiology (IFCN) has standardized the electrode placement system, known as the 10-20 system, where electrodes are placed at 10% or 20% (Teplan, 2002) intervals along the scalp.

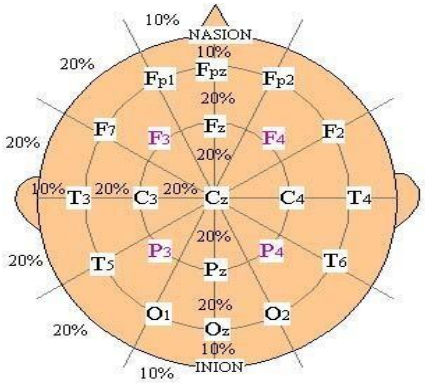

Fig. 1: 10-20 Electrodes Positioning System
Source: IFCN

Each electrode is labeled according to its corresponding brain area: F (frontal), C (central), P (parietal), and O (occipital). Odd numbers are placed on the left side of the head (Teplan, 2002), and even numbers are placed on the right side. Brain signals recorded during the data collection process appear as sinusoidal waves.

Spatial selection is a method used for selecting the EEG channels that exhibit the highest accuracy (Kamil, 2021). It involves two main processes: energy calculation and energy selection. The energy calculation process uses the I2-norm to generate energy values for all the channels. Energy selection, however, involves two techniques for selecting active channels: manual selection and automatic selection (Fauzi *et al.*, 2019). The most critical step in spatial selection is energy selection, which determines and selects the active EEG channels.

Below is a flow diagram of the system design used in the study. The system process consists of three stages: (1) data acquisition, (2) pre-processing, and (3) spatial selection. The EEG signal data undergoes pre-processing, where each channel is selected based on the highest energy levels using the spatial selection method. Once the highest-energy channels are identified, further calculations are performed to determine which channels exhibit the highest frequency of activation. These channels are then grouped into a new channel set, referred to as the "common active channel," which represents the entire set of respondents. The common active channel is used to recognize the signal patterns obtained from the respondents. The signal pattern recognition is based on the location of the channels in the brain and is related to the corresponding brain functions. The research flow can be seen in the Figures 2 and 3.

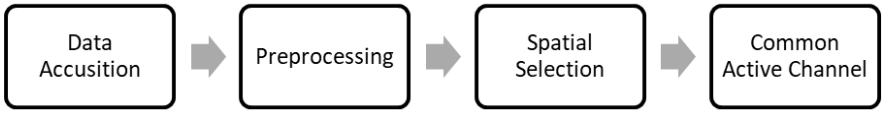

Fig. 2: Research System Design
Source: Authors, 2024

Fig. 3: EEG Data Accusition
Source: Authors, 2024

Result and the Discussion

Cirebon as a Cultural Attraction Space for Islamic Culture: Visual Stimulus through Film Video

The visual stimulus for the Islamic culture of Cirebon was designed through a film video. Tourism research indicates that videos can enhance tourism practices by conveying the images of destinations (Pan, Tsai and Lee, 2011), destination marketing (Paquin and Schwitzguébel, 2021), tourist experiences, and video consumption (Deng, Benckendorff and Wang, 2022). Videos surpass static images by combining temporal information, motion, and audio, offering a deep depiction of the scenarios (Schwenzow *et al.*, 2021). In fact, the videos represent events in real-time and provide a wealth of contextual information (Grewal, Gupta and Hamilton, 2021). They allow the viewers to experience and interpret content directly, thus offering valuable insights into its context (Gholamhosseinzadeh, 2023). They can capture

"sensual, tangible, and non-linguistic" interactions (Masset, Decrop and Frochot, 2024), facilitating a closer observation of the experiences of the tourists. In this simulation experiment, the Islamic culture of Cirebon was presented through this video format.

Manfreda, Ye and Nelson-Miles (2023) argue that tourism activities are often about allowing the tourists to dream and fantasize about their adventures. Therefore, the film video was designed to guide the fantasies of the tourists, particularly towards the historical and cultural landmarks of Cirebon. Cirebon has a strong historical connection to Islamic culture, with the royal palace still serving as a physical marker of the Islamic history (Figure 4).

The palace, as a historical symbol, is visualized in the video to represent the existence of Islamic history in this region. The cultural attraction of the mask dance of Cirebon is also visualized due to its moral messages to people. The use of entertainment media, such as mask dance, to spread moral messages of Islam has long been practiced by Islamic missionaries, including Sunan Gunung Jati in Cirebon (Agustina, Fauzi and Ekasari, 2022). The mask dance is depicted with a narrative of its historical significance and the meanings of the human characters represented by the masks (Figure 5). This visual narrative encourages the tourists to engage with the historical Islam of Cirebon through the mask dance.

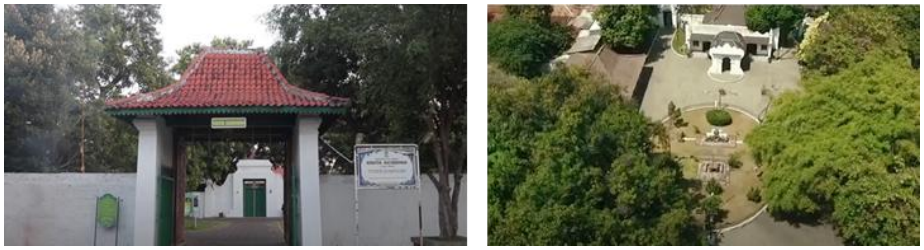

Fig. 4: Visualization of Keraton Kacirebonan (left) and Keraton Kasepuhan (right)
Source: Authors, 2024

Fig. 5: Visualization of Masks which Formed from Story and Characterization for Mask Dance
Source: Authors, 2024

Fig. 6: Visualization of Cirebon Mask Dance, Performed for Tourists in Keraton Kacirebonan
Source: Authors, 2024

Islamic culture of Cirebon appears authentic in the video. Authenticity highlights the historical spread of Islam and moral lessons for humanity. The authenticity is portrayed through narratives that engage and attract tourists. This is based on the increasing interest in historical sites, particularly in recent years (Goulding and Pressey, 2023). Cirebon, as a historical site, presents an authentic cultural attraction in the form of the mask dance.

Results of Brain Wave Channel Mapping in Response to the Islamic Cultural Attraction in Cirebon

The video film about the Islamic Cultural Attraction in Cirebon serves as the stimulus for measuring brainwave channel mapping. Channel mapping utilizes spatial selection to identify active channels and separate them from the others. This method results in a set of selected channels distributed according to certain criteria. Spatial selection is applied to each respondent to determine the relevant channel composition. After the channel selection, the number of active channels is calculated to determine which channels are most active. Total activity for each channel is divided by the total number of channels used, providing an average (Total active channels ÷ Total channels = Average). Channels exceeding the average level of activities are selected for further analysis, while channels with below-average activities are excluded from analysis.

The number of most-frequently-activated channels is termed the "common active channel." This set of channels represents those that are active in more than half of the respondents. Channels with activities exceeding half of the total number of channels across all the respondents are considered representative and are grouped together to form the common active channel, which serves as the active set for all the respondents. Based on the results of the common active channel, the active channels are associated with the brain functions corresponding to their locations. The common active channel can be seen in Figures 7 and 8.

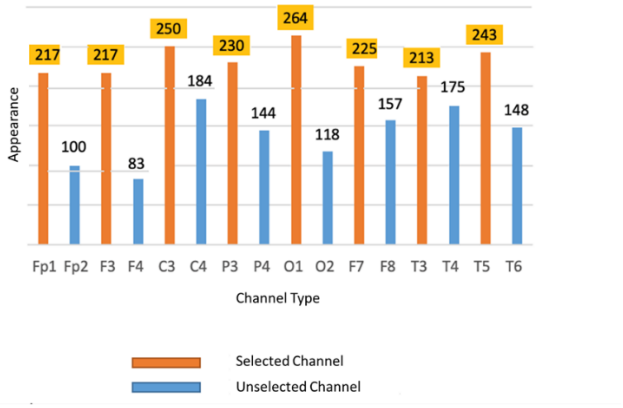

Fig. 7: Common Active Channel Results
Source: Authors, 2024

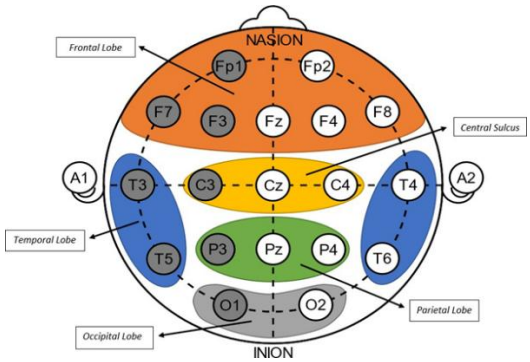

Fig. 8: Common Active Channel Mapping
Source: Authors, 2024

Based on the frequency of appearance, the common active channels across all the respondents consisted of eight active channels from a total of 16 channels, namely Fp1, F3, C3, P3, O1, F7, T3, and T5. This indicates that all these channels were active on the left hemisphere of the brain. The obtained channels were then linked to their respective brain functions according to their anatomical location, as described below:

Frontal Lobe: The channels within the Frontal Lobe showed high activity during the visual stimulus related to the introduction of Cirebon Islamic culture. The Frontal Lobe is associated with high cognitive processes such as thinking, working memory, concentration, and reasoning. The dominant active channels in this area were Fp1, F3, and F7, which were identified as common active channels, representing the entire group of respondents. These findings confirm that cognitive functions such as thinking and memory were predominantly active during the presentation of the visual stimulus related to Cirebon Islamic culture. The dominant activity in this area indicates active cognitive engagement with the stimulus.

Central Sulcus: This area showed activity during the visual stimulus related to Cirebon Islamic culture, primarily linked to physical actions such as movement, blinking, and sensory feedback from the interaction between the device and the scalp. The dominant active channel in the Central Sulcus was C3, which reflects involuntary movements or responses that occurred during the data collection phase.

Parietal Lobe: The Parietal Lobe is involved in processing sensory information such as touch, temperature, size, shape, and spatial awareness. In this study, the P3 channel was identified as the dominant active channel in the Parietal Lobe during the visual stimulus. This activity may have been influenced by the ambient temperature, as respondents were seated near air conditioning. This channel activity suggests that respondents were processing sensory information related to their physical environment during the visual stimulus.

Occipital Lobe: The Occipital Lobe, responsible for visual processing, was actively engaged during the stimulus related to Cirebon Islamic culture. The dominant active channel in this area was O1. This channel confirmed that respondents were engaged in observing and interpreting visual information, consistent with the task of watching a video depicting Cirebon's Islamic cultural heritage. The Occipital Lobe's activation indicates that the visual stimulus effectively engaged the respondents' visual processing centers.

Temporal Lobe: The Temporal Lobe, which processes auditory information and memory, was also active during the visual stimulus. The channels T3 and T5 were identified as dominant active channels. This suggests that respondents were not only processing visual information but also experiencing auditory stimuli and emotional responses related to the video. The proximity of T5 to the Occipital Lobe further supports the interaction between auditory and visual processing during the stimulus.

Based on the comprehensive data from all the common active channel acquisitions, the Frontal Lobe area exhibits predominant activity with 659 instances of activation, while the Temporal Lobe shows significant activity with 456 instances of activation. These results were derived by summing the activation data from each channel, revealing that the Frontal Lobe and Temporal Lobe regions demonstrate the highest levels of activity. This is attributed to the fact that the Frontal Lobe is associated with various human capabilities and activities, including intellectual functions such as cognitive processing, sustained concentration, reasoning, and the regulation of emotions and motor control. On the other hand, the Temporal Lobe is involved in functions related to auditory processing, memory, emotional responses, and visual information processing. Both of these brain areas are critically engaged when respondents are exposed to the visual stimulus, as all emotional responses, cognitive processes, reasoning, and heightened concentration occur during the observation of the stimulus, which in this case is a representation of Cirebon Islamic culture. Furthermore, the synchronization of auditory and visual processing between the ears and the brain is essential, leading to the activation of the left Temporal Lobe as the respondents engage with the visual stimulus. This function is an integral responsibility of the Temporal Lobe

The activities observed in the Frontal Lobe indicates the presence of cognitive processes, which result in the emergence of attention and even interest from the respondents

toward the given stimulus. Meanwhile, the activities in the Temporal Lobe suggests that memory processes are at work, alongside emotional responses from the respondents toward the stimulus. The video stimulus, which depicted the palace space and the Cirebon Islamic culture mask dance, successfully captured the attention of the respondents.

In the EEG measurements collected from all the participants, the Frontal Lobe and Temporal Lobe exhibited the highest levels of activity during the data collection process. When analysing the EEG results based on frequency sub-bands, the Alpha wave signal demonstrated activity in both the Frontal and Occipital Lobes, while the Beta wave signal showed activity in the Frontal Lobe and Central Sulcus. These findings align with the results from the questionnaire, which revealed that 64% of respondents reported an increase in knowledge, 22% noted a moderate increase in knowledge, and 14% indicated a slight increase in their understanding of the culture related to the stimulation provided.

Conclusion

This research concludes that, the brain activities of the tourists were highly engaged and corroborated by the questionnaire responses, confirming that Islamic culture continues to serve as a compelling attraction. Furthermore, the use of EEG devices enhances the objectivity of assessing tourist responses. The findings of this research support the notion that EEG (electro encephalography), a neurophysiological tool, can be utilized to study behavior and decision-making processes (Alvino et al., 2020). This also confirms that palace space and the Cirebon Islamic culture mask dance are prime tourist attractions in Cerebon and must be developed accordingly.

Real-time responses reflect genuine reactions from individuals, ensuring that no manipulative elements influenced the decision-making process. Therefore, it is concluded that neuroscience offers valuable insights into detecting interest of the tourists in cultural tourism in Cirebon. It suggests however, that further, more diverse research is warranted to expand on these findings. This study concludes that by employing neuroscience, it was possible to confirm that the palace, as a historical symbol, and the Cirebon Mask Dance, performed for the tourists in Keraton Kacirebonan are significant tourist attractions that excite them both visually, psychologically and intellectually.

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