Research on the transformation of smart museums under the Internet thinking: A case study on the palace museum

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Abstract

With the development of information and Internet technology, traditional museums have been long followed the trend of integrating innovative technological elements into the changed museums. It is necessary that the museums seize the opportunity of the trend transforming into smart museums, the key is to grasp the characteristics and laws of the Internet era, and use Internet thinking to explore the future development path. However, there are few studies on Internet thinking among the existing results. On the other hand, most of the relevant actual case studies still focus on the micro-level, which has obvious limitations. This paper will start from the current situation and trend, focus on the Palace Museum as a case study object, and discuss the problems and characteristics, so as to put forward the thinking about the development of smart museums in four aspects to explore the optimal path of transformation for smart museums.

Keywords: Smart Museum, Internet Thinking, Transformation Path, The place museum, Case Study

1. INTRODUCTION

Under the general trend of the Internet era, the shape of the museum has also changed. From the early traditional museum period, it gradually evolved into the digital museum stage, and then transformed into a new form - the "smart museum" which is now vigorously developing In China, the concept of a "smart museum" was first mentioned in the 8th by Beijing International Cultural and Creative Industry Expo held in 2013. Since then, it has attracted great attention in Chinese museum circles, academic circles, and even the national level. In 2014, seven excellent museums were selected nationwide as "smart museums" pilots, thus beginning the road of exploration for smart museums (He& Yang, 2018).

The "smart museum" has been developing for nearly ten years in China. During this period, the relevant state and policy have continuously issued clear instructions for supporting to the "smart museum", constantly emphasizing its importance in the future. Whether it is the instructions from policies, the general trend of technological and social development, or the internal needs of museums, it all shows that "smart museums"are the future of the museum industry. Many scholars have also launched a research boom in this field. Chen (2013)

believes that the four key intelligent technologies can clearly define the application in the smart museum, which has a wide range of influences. Also, lv and Chen (2019) propose that the transformation of the smart museum management model can be a kind of business model, and switch the traditional passive browsing and publicity into active communication, which broadens the train of thought for the development of the smart museum. However, the integrating emerging technologies into museums is not as simple as using technology to support it. Only grasping the characteristics and thinking of the times, and integrating them into the development of the museum industry is the inevitable choice for a traditional industry to carry out reform in the era, facing fierce competition and rapid iteration. The great "change" in the Internet age is taking place now. The widespread use of the Internet has escaped the original tool attributes, and has been sublimated into a kind of thinking, which affects the development direction in various aspects. Also, the transformation of traditional industries requires thinking about future development, under Internet thinking.

Therefore, this study will explore and optimize the smart museum industry in the new era under Internet thinking, by researching the Palace Museum as the case study object analyzes its process and achievements.

2. THE THEORY AND BACKGROUND

2.1 The concept and characteristics of the Smart Museum

2.1.1 The concept of the Smart Museum

Representatives of scholars in Japan and the West, Eiji Mizushima (1989) and Ruotsalol (2013), have proposed the definition of a smart museum, arguing that a smart museum can automatically control the information transmission, exhibition and preservation environment, which can provide the various and personal experience for the audience. With the introduction of "smart museums" into China, Chinese scholars also put forward their unique insights. In the Chinese academic circles, Zhang and Wang (2012) introduced the "I-Museum System", and believed that the smart museum is a service museum based on modern technology where centred on the the audience's needs. In 2017, the publication of "Smart Museum Cases (Volume 1)" provided a clear definition for the concept research of smart museums, expressing as "through the full use of information technology, such as the Internet of Things, cloud computing, big data, artificial intelligence, to calculate and analyze the information related to the operation of the museum, including people, objects, activities, to improve the service, protection and management capabilities." This is considered the general definition of the smart museum at present (Technical Innovation Alliance for Cultural Relics Protection, 2017). Based on the above overview, the study defines the smart museum as using information technologies, including the Internet of Things, cloud computing, big data, and artificial intelligence to make full use of digital resources to optimize education, research, conservation, collection and display functions in the museum.

2.1.2 The characteristics of the Smart Museum

Adding a new generations of information technology allows museums to process data more freely, and the sensor automatically-collected replaces manual input information, which greatly improves the efficiency and capacity. The interconnection of data and the ability of independent analysis systems also enrich the way of data application in museums, which constitute a new work system, and form the different characteristics from the past.

Firstly, it makes full use of various resources to realize coordination and cooperation. The system in the smart museum, from data collection, data interconnection, and big data analysis to execute, has a clear division of labour at three levels to jointly build an interconnected working relationship. Therefore, the distinctive

feature of the smart museum is the dynamic and diverse interconnection, which can coordinate and cooperate, and optimize and integrate resource allocation, so as to make the operation more efficient.

Secondly, it breaks the limitation of information collection. In the past, collecting information mainly relied on semi-automatic collection and manual, where the data collection cycle was usually long, and there were certain requirements for the space. Comparing, the data collection process in the smart museum relies on the full-automatic system including the collection, storage, management, and sharing, which turns into a real-time and dynamic method. It not only realizes real-time updating but also lower the cost.

Thirdly, the smart museum also shows "people-oriented". In the smart museum, technology is only a means to assist "smart", and its ultimate purpose is still to serve and educate the public, and promote the cultural prosperity and development (Wang, 2019). The work of the Smart Museum revolves around the audience's needs, standing from their perspective, thinking about what they think, and doing what they need, which can provide the audience with comfortable and friendly services, stimulating the audience's enthusiasm, and guiding them to participate.

2.2   The concept and characteristics of the Internet thinking

2.2.1 The concept of Internet thinking

The Internet, originally used as a tool, has realized information sharing and communication worldwide the world. With the prosperous development of technology, the Internet has gradually become closely linked with people's lives, completely changing human production and way of life, even infiltrating their cognitive style, interpersonal relationship, thinking style, worldview, and values, forming a kind of "Internet thinking". Its evolution from tools to think is an inevitable law of historical development as the American scholar Steve Lorre believes that technological changes affect not only behaviour but also human thinking (Steve, 2015).

In 2011, Baidu whose founder called Li Yanhong first proposed the concept of "Internet thinking" in a speech "Three New Opportunities for Internet Entrepreneurship in China", and he stated that traditional industries have certain limitations in understanding, accepting and use to the Internet, and "Internet thinking" has not been applied to the industry. After that, the idea of "Internet Thinking" intensely aroused social repercussions, and several administrators in famous IT companies responded quickly, such as Baidu, Alibaba, Tencent, and Xiaomi, Etc. Therefore, Internet thinking has also received attention from all walks of life, and has even been raised to the height of national strategy. In 2013, a propaganda report titled "What Internet Thinking Brings" was broadcast on CCTV News Network, which was the first time Internet Thinking appeared in the official media. Later, the national strategy also mentioned "Internet thinking", and pointed out that "the integrated development of traditional media and emerging media should follow the law of news communication and the emerging media, and strengthen Internet thinking" (Xinhuanet, 2014). Subsequently, the influence of "Internet thinking" was further expanded and gradually became known to the public. With the of "Internet thinking" into the national guidelines, it has caused a research upsurge in all sectors of society. Many scholars and entrepreneurs have given unique insights into this new and vague concept.

Shao (2015) believes that "Internet thinking for the industry is a new ecosystem, which is decentralized, heterogeneous, diverse and perceptual. It means that Internet thinking can be seen as a kind of cognition, and applied to various fields. This statement points to the characteristics of Internet thinking used in the industry. Also, Ma (2017) states the unique definition that Internet thinking is the product of the development of Internet technology to a certain stage. It is a brand-new thinking mode to be guided to various industries in the Internet era. On the other hand, internet thinking also attracts the attention of the business elite. Lei in MI believes that the characteristics of Internet thinking are focus, extremeness, word-of-mouth, and fast (Yi, 2014). Similar,

Ma in Tencent describes more specific that internet thinking has seven characteristics, respectively connecting everything, innovation in the Internet era, opening collaboration, consumer participation in decision-making, data becoming a resource, courage to follow the trend, and negative risks for connecting everything (Zhao, 2014).

Based on the above existing research results, the researcher believes that the characteristics of Internet technology have gradually affected ideological responses, and evolved into a problem-solving way of thinking. Therefore, combined with the research background and existing research, Internet thinking can be defined as cognitive thinking based on the functions and characteristics of the Internet. The transformation of the smart museum in China needs to re-examine the development of the industry through it, and promotes a new pattern.

Internet thinking is a way of thinking based on the continuous popularization and development of Internet technology. Therefore, the characteristics of Internet technology or application are the basis for the evolution to Internet thinking. From its definition, it is not difficult to see that Internet thinking can also be regarded as a relatively general statement. Any thinking with Internet characteristics, application rules, and laws can be called Internet thinking. Due to the diversity of the application on the internet thinking, many kinds of ideas are extended. Chen (2014) divides Internet thinking into twelve categories, including traffic thinking, product thinking, simple thinking, integrated thinking and so on. In addition, Zhao (2014) think that Internet thinking includes nine aspects, big data, iteration, socialization, extreme thinking. Based on the current results, this research divides Internet thinking into the following aspects:

Table 1. Main ideas of Internet Thinking

Main ideas	contents
User thinking	Everything is user-centred, and all services and work are based on the users' needs. User thinking requires operators to follow the principle of user supremacy, thinking about the users' need from their perspective, and all production and operation work is constructed on the user's needs.
Cross-border thinking	A new type of thinking concept and thinking mode by grafting ideas and modes from different industries or fields, or by innovating or transforming them. The fields originally unrelated or even contradictory can penetrate and integrate, to create an entirely new system, structure or process.
Big data thinking	Big data thinking refers to the way of thinking to tracking, mine, and understand the value from industry-related data, and even create new value.
Socialize thinking	Socialize thinking means that producers should actively use social tools, such as social media, and social networks, to establish a good communication relationship with users, pay attention to humanistic care, and form emotional bonds with them.

Source: Compiled by researchers

2.2.2 The characteristics of the Internet thinking

Based on the above, there are certain understanding of the concept and main types. It is the internalization of social practice activities in the human brain, and the rational expression of people's way of life. However, as for mastering and using a kind of thinking, the study for its characteristics cannot be ignored. Therefore, the following will specifically explore the characteristics of Internet thinking.

Firstly, Internet thinking has the characteristics of decentralization. supposing the huge Internet is regarded as a platform for information exchange. In that case, every individual participating or involving in the network has the ability to send and receive information, thus becoming a node on the Internet. In this system, the

operation of each node is not affected by the outside world, but can be connected to form a relationship that is both connected and independent. Therefore, each node on the Internet has the same role and ability, there is no priority between the centre and the edge, forming a non-linear, open, and equal structure, which can also be called "decentralization".

Secondly, the characteristic is the wide connection. The Internet breaks the limitations of time, space, and even industries and concepts. It seems that in the Internet era, anyone, anything, any time, and any place are connected, and can communicate, interact, and think from all directions. And this kind of extensive connection puts the channels and sources of contact information got into a state of diversification so that the thinking can be more in-depth, thorough, extensive and comprehensive.

Thirdly, Internet thinking has a recurring feature, which is formed based on extensive connections. As the Internet the dissemination and circulation of information prompted, the huge scale of information circulation enables each individual to access a variety of complex and uneven information sources. Therefore, it is not only necessary to understand local information connected between them, but also understand the overall results and functions, which form the systematic nature.

2.3   The necessity of smart museums transformation guided by Internet thinking

Internet thinking is a way of thinking that reflects the characteristics and the requirements of the times. Applying this thinking to guide the development of smart museums has become an inevitable choice in the current. The specific reasons are as follows:

2.3.1 The new achievements in the industry

With the continuous updating of Internet technology, the meaning of Internet thinking will continue to develop, change and deepen. Therefore, the meaning of Internet thinking is a dynamic process. The emerging new technologies and ideas have injected new blood into the museum industry one after another, making the process of transformation full of various fresh and unique designs and unprecedented changes. Whether it is the development of cultural products, service work, or research on the protection of cultural collections, they are in a dynamic process of constant change, and they need to be constantly adjusted according to the market and environment in which they are located. Therefore, in the transformation of smart museums, it is necessary to firmly grasp and use the updating Internet thinking, so that it can maintain the vitality and competitiveness of the industry, and always have keen insight into the changes in the general environment.

2.3.2 The new value in the industry

The extensive connection of Internet platforms has brought the capacity of information to an unprecedented height. However, the connection does not only refer to a wide range between network terminals, such as PCs, tablets, collections, and watches. It is also a cross-border connection between industries, which can create new values in the field. In the Internet age, the connection between museums and the outside has more convenient channels than ever before, and there are opportunities for mutual understanding with other industries. This allows the museum to have a more diversified and extensive development, which can break the original pattern, and get breakthroughs with help from other industries. On the other hand, the collision and fusion of different fields can also enhance the shortcomings of the museum industry, to continuously dig out new value through cooperation. Therefore, using the widely inter connected nature of Internet thinking, realizing cooperation in new fields, and expanding or mining new value is essential for future development.

2.3.3 The new ecology in the industry

The dissemination of information is no longer in the hands of the mainstream media, resulting in decentralization. It is necessary to respect the law of Internet, and use Internet thinking to guide, How new features and methods can play a role in the museum industry. Whether it is big data thinking or user thinking, it reflects the emphasis on each individual. Only by respecting the voice of users, fully understanding their needs, and actively interacting with them, the audience can feel transformed from an experiencenr to a participant, to form a co-construction relationship between the museum and the audience, which promote the museum industry to form a new ecology pattern.

3. THE STATUS QUO AND CASE STUDY: TRANSFORMATION OF SMART MUSEUMS IN CHINA

3.1 The Status Quo: Transformation of Smart museums in China

Traditional Chinese museums revolve around the five major functions, education, research, appreciation, collection, and protection, and divide their business categories according to them, including exhibition, research, and collection preservation. However, the division or execution of work is relatively scattered, and each part of the work performs its duties. After the museum has entered the stage of intelligent transformation, due to the integration and interconnection of information resources, the previous business has begun to blend, forming a new business division, covering its original functions and missions, and further expanding the play of functions, namely smart services, Smart Protection, and Smart Management.

First of all, it is the transformation to smart services, and the its business composition is mainly evolved from the original work in exhibition and education aspects. It is aimed at public service needs, using digital technology and information technology to dynamize museum resources, restore historical and cultural resources, display interactive forms in multi-dimensional, multi-channel information real-time push, cultural and creative product manufacturing and sharing, to achieve a high degree of interaction between the public and the collection (Technical Innovation Alliance for Cultural Relics Protection, 2017).

Secondly, it transforms into smart protection, which mainly integrates the functions of research and storage. Based on intelligent perception technology and non-destructive testing technology, it conducts a comprehensive quantitative analysis of collections. Data mining and analysis helps scholars explore the quality of collections that are difficult to study manually. In addition, it can grasp the collection's characteristics before it is damaged, and then use the data to build a model to form a three-dimensional visualization result, forming a smart protection system that integrates the diagnosis, analysis, processing and evaluation.

Thirdly, the smart museum can automatically collect data, so the workload of information collected is far greater than the previous. And due to the diversification of data collection channels, also increases the burden for backstage supporters and audience data management, which together constitute the new business focus of smart services. As for smart management, all basic information of collections is contained, including recording, management status, research, protection progress, exhibition loan, Etc. The real-time mastery of the collection can finally realize dynamic management, and reduce the risks in management. On the other hand, by optimizing the information platform, the various business links, human resources, collections, financial resources and other resources can be checked on the intranet, and the risk of unclear responsibilities between internal departments can be further solved.

3.2 The case Study: Transformation of Smart museums in China

The transformation of smart museums in China is still in the exploratory stage, and there are relatively few forming theories. However, many museums have begun to try to use emerging information technology to move toward the road of transformation, which provide cases worthy of reference. Therefore, putting forward the suggestion on the transformation of smart museums under Internet thinking, this research will select the Palace Museum as the object of the case study, analyze its transformation achievements and process in-depth, and discuss its strengths and problems.

3.2.1 The Transformation Process of the Palace Museum

The object of this case study is the Palace Museum (Beijing), which has the largest collection and scale in China. In the early 1990s, it pioneered the informatization museum in China. After more than 30 years of continuously integrating new technologies and innovations, it has maintained a leading role in the modernization of museums. Seen from its development path, it can be divided into three main stages, the period of informatization and digitalization, the period of initial smart museums, and the period of advanced smart museums.

1) The period of informatization and digitalization
In 1998, the Palace Museum started its informatization construction. First, the informatization construction was locked in the collections, and a collection management information system was built. The system records the attributes and information of more than 1.8 million collections, so that can be easily displayed to the manager, such as the specific name, size, basic identification information, Etc. Later, it continued to upgrade and innovate to form a comprehensive collection management system, which transformed the data capture originally recorded by paper and pen into digital information. This meticulous and huge information input work was all done by hand typing word by word, and it took more than a year to complete this work in 1999. In addition, in the same year, the information network system and cables project were reconstructed. After five years with three phases of expansion and reconstruction, 12km of optical cables, 60km of twisted pair cables, and 24 network points were laid, which linked various businesses and departments together to prepare for digital museums.

As for the first stage, information technology is mainly applied in the data capture simply, but the two information construction projects have great significance. First of all, the Palace Museum is the first museum in China to involve in information construction, marking the museum's transformation towards modernization in China. Secondly, it contains as many as 1.8 million collections, and has a huge workload to manually input their data, which laid a solid foundation for the subsequent redevelopment of digital resources. In addition, in the Internet era, the development effect and influence of digital resources are inseparable from the network foundation. The upgrade and strengthened network and related technical facilities have broadened the circulation channels for dissemination. In general, at this stage, the Palace Museum has completed the most basic and tedious basic work, providing powerful data resources for subsequent development.

2) The period of initial smart museums
With the database established, the management businesses have been quite effective, and the managers also have preliminary confidence in using information technology to strengthen their daily work. During this period, based on the collection management system, the collection circulation system and the administrative management platform were established according to the work needs. The collection circulation system is upgraded and transformed based on the previous collection management system, which facilitates workers to

extract, research and display. In addition, after the database is established, how to develop and utilize it to maximize the effect to the audience has become the biggest problem. The support from overseas has become the driving factor for the rapid development in this period. At the same time, the Palace Museum has also chosen to cooperate with local excellent technology companies and universities to jointly develop, and use advanced digital technology to create a series of outstanding and cutting-edge achievements.

① "The Forbidden City Beyond Time and Space"

On October 10, 2008, the "Forbidden City Beyond Time and Space" project, a collaboration between the Palace Museum and International Business Machines Corporation (IBM), was officially released. This project builds the Forbidden City with network 3D virtual technology and designs thematic tour routes, historical scene reproduction and recreational activities. This is the first completely virtual world created based on historical attractions, which integrates rich content, vivid historical scenes and narration, enabling viewers from thousands of miles away to visit the virtual Forbidden City, and communicate with other virtual visitors. Meanwhile, the game uses high-resolution and 3D modelling technology to virtualize palace buildings, cultural relics and characters, as well as design 6 tour routes for audiences.

Figure 1. "The Forbidden City Beyond Time and Space" (watermelon, 2015)

② The series of apps produced by the palace museum

Beginning in 2012, the Palace Museum began to try to develop APP applications based on smart mobile devices. At present, 10 apps have been developed and launched, which are beautifully designed. Furthermore, it provides detailed and interesting learning materials for the audience's cultural experiences with rich content, which switches uncommon history into interesting.

Figure 2. Series APPs produced by the palace museum (Vincent, 2019)

③ Digital exhibition hall

At the end of 2015, the Palace Museum transformed a palace into a "digital exhibition hall"with almost no physical collections, and all exhibitions are displayed on high-definition electronic screens through 3D models. On the basis of new technology, it tries to break the distance between traditional culture, collections and audience by combining online and offline, and provides the audience with an interactive experience with visual effects and interesting exhibitions. This exhibition hall is divided into three parts, including the digital collection display, the virtual interactive area, and the virtual theater.

Figure 3. Digital Collection Display, Virtual try-on equipment, and Virtual Theater (The palace museum, 2017)

④ Digital Forbidden City Community

In 2013, the Palace Museum put forward the concept and goal of the "Digital Palace Museum", and it took nearly 3 years from the conception to the gradual realization. The "Digital Forbidden City Community" was officially released to the public in 2017, and is continuous improvement and updating. The Digital Palace Museum tries to create a museum that combines virtual and real, which exist apart from the physical museum, and realize the support to information service and interpersonal communication, to create a source aggregation platform that integrates online and offline. Users can learn and experience the Forbidden City on the Internet in digital form. In other words, it is to move the physical Palace Museum to the Internet, and bring together all the people who pay attention to the Palace Museum in the form of a community (Feng, 2017). The structure of the digital community is divided into eight aspects, which are social square, cultural display, information dissemination, tour guide, academic exchange, public education, leisure and entertainment and e-commerce, which pushes all the business work of the Palace Museum to the public through the community, allowing them to learn and apply this information in the online community.

Compared to the previous period, there is a qualitative leap and involves many fields in this stage, including internal administration, monitoring and analysis of collections and data, as well as many cultural products that have invested the most energy. Meanwhile, it has rich cooperation channels and various cultural products, by gathering excellent technology companies, starting from the audience's preferences and needs to design.

However, it is not difficult to see from the achievements in this period that most of them are still using digital technology to develop resources. As for internal administrative management, it integrates and improves the office process, standardizes the system, and promotes quality through combining digital resources and network technology. But it has not yet reached the blueprint of the smart museum concept, only realizing data capture and sharing in real-time, and still lacking in data autonomous analysis and decision-making. As for the monitoring and protection of collections, the researcher believes that it is the most "intelligent" awareness part in this stage. Data capture is mainly converted into digital signals through sensing equipment, and dynamic real-time data is formed through 24-hour constantly monitoring. Finally, data analysis in the system can help workers make decisions, and even autonomous processing. For example, when the humidity and temperature

monitoring system finds that the temperature of the exhibition hall does not reach the set standard, it will automatically adjust, truly realizing the two-way connection between "things" and "things".

In addition, the biggest achievement in this period is the research and development of cultural products for audiences. From the perspective of the main project, the products have broken through the physical limitations in the museum space, and combined online and offline. Online products are mainly developed through cooperation with excellent technology companies, using game methods that are easily accepted by the audience, and integrating cultural content into the game, so that the audience can learn knowledge in fun. Different from the "Forbidden City Beyond Time and Space" in the early days, the " series of APP" has begun to develop towards the mobile terminal, keeping up with the trend of the times, and providing social functions in the game, allowing users to connected together in the network. On the other hand, the concept of the "Digital Forbidden City Community" has been initially formed and put into construction, which maximizes the value of data and network. Also, it creates virtual cyberspace that connects the public closely with the Palace Museum culture. At this time, the Palace Museum is no longer just a museum, but a part of public life, so that the public can fully participate in it and give full play to its social function.

Overall, during this period, the Palace Museum has acquired a "smart" awareness in various businesses, especially in the monitoring system with "autonomous behaviour". And it tries to use features of data to break the boundaries and explore the relationship between museums and the public in cyberspace.

3) The period of advanced smart museums

In 2018, with rapid technological development, such as cloud computing, big data, artificial intelligence and mobile network technologies, the Palace Museum has entered a period of advanced smart museums. Compared with the digital technology-dominated situation in the previous stage, the information technology with intelligent characteristics became the main support in this period, which made the Palace Museum regain its vitality, and even possess the wisdom of "thinking". Chinese local high-tech companies became the main partners during this period, introducing intelligent information technology into the culture, collection restoration, public services, etc., which were put into use and were well received by the audience.

With the maturity of technology and the implementation in projects, the vague concept -"smart museum" has gradually become clear. The ideal blueprint for a smart museum presents a trend based on digital data and intelligent information technology. During this period, it is not difficult to see that the key technologies with intelligent features frequently emerge in the projects., such as "artificial intelligence", "cloud technology" and "Internet of Things" .The Palace Museum as a whole has entered a comprehensive intelligent transformation, gradually transformed from a form dominated by digital technology to one dominated by intelligent information technology, and has built many achievements:

① Tencent Smart Games

In 2018, the "Eyes· Dream" smart game independently developed by the Palace Museum and Tencent was unveiled, which is Tencent's first cutting-edge game that uses eye-tracking technology. It is Combined with the traditional paintings and calligraphy in the palace museum, and triggers operations by recognizing human eye movements to achieve real-time synchronization with the screen. The game screen is based on Chinese classic calligraphy and painting, and players can experience their charm in the interaction. In the game, players need to look for some details and differences in the wooden cards on the game screen. As long as the "eye" sees the wooden cards, it will be turned over and displayed, which tests the player's reaction, instant memory, and reasoning ability. Also, this is the first game operated with "eyes" around the world, using Tobii's eye-tracking technology to completely get rid of the keyboard, mouse or handle, and even a helmet device is not required.

② AI guide program

In 2019, the Palace Museum produced an AI guide chatbot "See the Minister", which can chat with tourists at any time through the We Chat applet. The database of chatbots contains 670 interesting questions and answers from documents, such as "The Collection of Living Notes in the Qing Dynasty" and "Records of Qing Dynasty", which makes the chatbot can imitate the communication habits to chat with the tourist in a humorous way. Also, it supports voice communication in that users can input their voice in WeChat and have a question-and-answer dialogue with the virtual minister presented on the big screen, by introducing a customer service robot system from Wofeng Technology intelligent.

Figure 4. "See the Minister" AI intelligent chatbot (Qubit, 2018)

③ The "smart " palace museum in the future

After Huawei and the Palace Museum signed the cooperation intention, Mr Shan, former director of the Palace Museum, delivered a speech on the theme of "AI + Culture" - Bringing Cultural Heritage Resources "Alive" at the 2020 World Artificial Intelligence Conference, and Released the blueprint of the smart palace jointly envisioned with Huawei. In the plan, the overall structure of the Smart Museum is based on "big data", "cloud computing", "Internet", "artificial intelligence" and other technologies, using data capture, storage, computing, management and application, to form a "smart brain", which supports all the business work in the "smart Museum". Its business core is divided into four categories: management, service, administration, and maintenance support.

In this period, with the maturity of technology and previous experience, the achievements have the ability to handle intelligently and autonomously. And it began to explore the new structure of the smart museum, no longer satisfied with the technology applied on traditional museums, but to use the characteristics of data and technology to build a new pattern that can make better use of digital resources. The research time range was selected from 2018, due to the short development time. Until the submission of this research, only a few achievements have been implemented, and many projects are under construction, but relevant documents, plans, and meetings have pointed out the future development direction. Judging from the current construction achievements and deployment, there are two major trends. First of all, compared with the previous, this stage no longer frequently cooperates with foreign companies to jointly develop but instead chooses to cooperate with local top technology companies. In 2019, the Palace Museum conducted strategic cooperation with two Chinese technology giants, namely Huawei, which has the world's leading 5G communication technology, and Tencent, which has made great achievements in the fields of multimedia and games. There are two main reasons for this. In recent years, the rise of information and network technology in China, especially the development of 5G technology, has become the first echelon around the world, so the local science and technology with fast-developing become the main support. On the other hand, the cultural value and collections

contained in the Forbidden City are the essence of traditional culture in China. Therefore, when working with foreign teams, language barriers and culture shock have become the major difficulty.

Although foreign teams can provide advanced technology and solutions, their understanding of Chinese culture is not as thorough as that of local teams. Therefore, it chooses to cooperate with Chinese technical teams, which is beneficial to the combination of technology and cultural connotations. Meanwhile, it can be seen from the current achievements that AI technology has been strengthened in the smart service for the audience. Compared with the previous stage main relied on data to develop digital cultural products, it is more capable of "self-thinking" in this period. In addition, the speech to the future Palace Museum also reflects the breakthrough for the original work pattern. In the future, the Palace Museum will be based on a data-centric work pattern. Its original organizational structure and workflow are no longer suitable for a smart museum supported by technology. Therefore, a new museum system that is supported by technology and data-centric will be built, which is also a nessesary issue to be considered for further development.

3.3 The advantages and disadvantages of transformations

3.3.1 Advantages

Firstly, making the best use of the user thinking. After the Palace Museum established the hardware information infrastructure, its digital cultural products began to blow out. From the early "Forbidden City beyond time and space" to the last series of APPs, applets, and "The Digital Palace Museum, which all rely on software platforms and forms familiar to the audience. Therefore, when the audience touched it will not feel difficult to approach, which invisibly lowers the threshold for use. Not only games, animations, movies, and other display forms that audiences like, but also software platforms with high audience participation, such as WeChat and applets, have been incorporated into the intelligent construction. It is not hard to see that fully takes into account the life and usage habits of the audience, which reflects the concept of "audience first".

Secondly, optimizing museum services through data. The Palace Museum put forward the blueprint for the establishing a "digital Palace Museum" at an early stage, which connects and gathers scattered audiences by creating a communication platform. Also, it is the main source to collect data and information from audiences. The value of audience data is far more than that. The reason why "AI" guides can communicate with the audience autonomously in the later guide applets precisely is that more than 70,000 pieces of audience information are collected to the audience database, which Can respond to a variety of questions their. Huge and diverse databases have become an important support for smart museums to optimize its quality. Therefore, how to use, understand, process these data, and create value is the core of big data thinking.

Thirdly, actively cooperating with resources from all walks. The Palace Museum actively cooperates with other industries across borders, which can make up for its shortcomings, and create new values. On the one hand, it actively conducts cross-border cooperation with the communication industry. In the era of rapid Internet development, the application of 5G technology is the basis for realizing efficient and real-time data connections. On the other hand, the extension to games and social platforms has become another trend. With the increasing popularity of video and online games, the traditional model of information dissemination is gradually replaced by the mode that combines culture and game. With the development of technology, data resources can be circulated and reused. Under cross-border thinking actively seeking cooperation in fields that match museum resources, which can explore not only new values, but also integrate inefficient work.

Fourth, the relationship with the audience is narrowed, through close social interaction. From the perspective of socialized thinking, there are mainly two ways to prompt the transformation of the museum. The Palace Museum used the concept of community in the early days, and while constantly exploring new forms, it also

greatly emphasized to building group connections between audiences. Social thinking is used in the game "Forbidden City Beyond Time and Space" in cooperation with IBM, and a virtual society is constructed in the game. Players from all over the world can communicate with each other in the virtual game. The "The Digital Palace Museum" project uses socialized thinking more thoroughly. It aims to separate from the real museum and build a virtual society, which brings together all people who pay attention to the Forbidden City.

3.3.2 Disadvantages

From the transformation process of the Palace Museum, it is found that its problems mainly appear in two aspects. On the one hand, the organizational structure is no longer suitable for the needs of smart museums. In the past, the main organizational structure of the museum was composed of three major parts: the management department, the exhibition department, and the preservation department. However, with new technologies, the previous organizational structure is no longer suitable for new needs. The new focus of work revolves around "data", which becomes the core, and its organizational structure should follow the new business centre. Therefore, museums must adjust their work pattern, workflow, and organizational structure accordingly.

On the other hand, the operation and maintenance are insufficient in the later. Compared with the previous forms of museums, the Smart Museum uses an endless stream of new technologies to help its work, achieve technological breakthroughs, and change the boring display method in traditional museums. However, during the field investigation, the researchers found that some projects invested a lot in the early stage, but they could not achieve sustainable development in the later stage, and even stopped using it. The researchers believe that this problem is mainly due to the high cost and the lack of high-level maintenance technicians in the museum. Therefore, how to break the deadlock, and opening up a new mode of operation and maintenance is a difficult problem for smart museums to face.

4. THE TRANSFORMATION OF SMART MUSEUM UNDRER INTERNET THINKING

4.1   Building a service-oriented smart museum

Information technology has changed the one-way information transmission mode, and audience groups have channels to express their self-awareness. Whether the audience directly participates in the activities of the museum through the Internet, or the museum service provides rich, fast and personalized cultural products to the audience with different needs, it all reflects the user thinking of the smart museum. Firstly, from a long-term perspective, museums find the needs of target audiences, which are not only functional but also emotional appeals. Similarly, the humanistic value of the museum is reflected in the broadcast cultural value, and it is also the carrier of human spiritual civilization. Therefore, only by adhering to the principle of being "people-oriented", respecting the needs of the service object, and building a service-oriented smart museum, which can put it on the right track, to exert the service function. The concept in the museum is that around "people" coincides with the user thinking. In other words, the most important "user" in a museum is the audience it serves. Therefore, the new form of the smart museum should use "user thinking" to provide a channel for the audience to speak, and respect their humanized needs, to make the audience feel like owners in the museum.

4.2   Finding new value through Cross-border cooperation

After the museum integrates the power of science and technology, the dissemination of information is fast and convenient. The smart museum has more extensive connections than ever before, gradually weakening the differences between information, lowering the communication threshold, and forming an existence without

boundaries. The breaking of restrictions is manifested in all aspects, not only is the virtual museum breaking the limitations of space and time at the physical level, but also breaking the boundaries between the museum industry and others. In the new era, the development of smart museums should also take advantage of technology to use cross-border thinking integrating resources in multiple industries, fields and channels. It can create a comprehensive and borderless smart museum, subverting the barriers of traditional museums in terms of time, space, form, efficiency, and business scope. Therefore, smart museums based on cross-border thinking are mainly divided into two ways. One is based on vertical integration to improve efficiency. Another one is to seek horizontal expansion for new opportunities, to break the bottleneck of industry development, and break through the original pattern. However, no matter what kind of purpose cross-border, the cooperation between industries is not enough to only rely on the information of mutual penetration, and the key is to pay more attention to the target "audience".

4.3   Restructuring the organizational structure with "data" as the core

Information can be freely and widely disseminated in a museum in the internet age. All museum-related elements such as audiences, collections, staff, and artists can be regarded as nodes in the information circulation network, which are connected and influenced by each other, forming a decentralized communication mode. Diversified information carriers are digitally processed to form a unified communication language. In other words, information in different media such as pictures, audio, and video can be converted into a unified "data" language and spread through the network. Also, Data has become the core of the Smart Museum. From data collection to dissemination and reuse, the centre businesses all revolve around "data", which is completely different from the traditional museum's operational characteristics and business work. Therefore, smart museums should fundamentally transform their ideological concepts, systems, business content and methods. Furthermore, it correspondingly changes or reshapes the mode, pattern and Processes. As well as, the organizational structures need to be adjusted according to their new characteristics to improve work efficiency.

4.4   Establishing a new ecology with the public

The core of the new ecology for the Smart Museum is "relationship". However, the relationship is a very broad concept, such as relatives, friends, and classmates, which are all different relationship layers, and information dissemination between different relationship layers also brings different effects (Zheng，2019). Therefore, what kind of relationship should be established, and how to establish an ideal relationship are the central issues for building a new ecology of smart museums with its audience. First, museums and audiences should establish a "fan relationship". The two play the role of "consumption and service" to make the audience like to go to the museum, and even become the loyal audience, so the museum needs to consider how to form a loyal fan relationship between the two. Second, museums can also serve as platforms to help audiences form community relationships. The contact point between museum visitors is that they visited, or are interested in the same museum. In other words, audiences are connected based on the same values and interests, and people with similar interests are united to form community relationships. The changes in connection methods with technology not only create new relationships between museums and audiences, but also increase the influence on museums from audiences. Therefore, only by managing the relationship between all parties can find the right direction for the development of smart museums.

5. CONCLUSION AND SUGGESTIONS

This research is based on the related theories of smart museums and Internet thinking. It analyzes that Internet thinking can promote the transformation of smart museums, such as creating new achievements, new values, and new ecology in the industry, to form the necessity of the transformation of smart museums with Internet thinking.

In addition, in order to further analyze the advantages and disadvantages of smart museums under Internet thinking, the Palace Museum is selected as an example to be analyzed its achievements and transformation paths in three different stages. On the one hand, the Palace Museum utilizes and fully displays user thinking, big data thinking, cross-border thinking, and social thinking, showing many advantages, such as taking the audience as the protagonist, using data to optimize museum services, actively cooperating with all walks of life, and promoting relations with the audience. On the other hand, its shortcomings shows that the organizational structure is no longer suitable for the needs, and the maintenance is insufficient in the later stage. Finally, based on the above advantages and disadvantages, the thinking on the transformation of smart museums in china under the Internet thinking mainly comes from four aspects, respectively building a service-oriented smart museum, cross-border cooperation to find new value in the industry, and focusing on "data" as the core on organizational structure, and building a new ecology with the public.

This research explores the new appearance and form of smart museums to meet the new needs of the audience, and provides a reference for the transformation of smart museums in China on the current stage. However, the rapid iteration of technology will continue to produce more and newer technologies at a speed and scope beyond people's imagination. The use and impact of emerging technologies in the museum industry will certainly continue to revolutionize perceptions, far beyond the range of this research at this stage.

However, this study has limitations in the degree, which mainly comes from the two aspects. Firstly, as for the validity of time, the rapid iteration of technology will continue to produce more and newer technologies at a speed beyond people's imagination. The application and impact of emerging technologies in the museum industry will certainly continue to innovate cognition, and future developments are far beyond the scope of this research at this stage. Secondly, the breadth of research is not enough. Due to the limitation of time and social resources, the depth and breadth of case study data acquisition are not enough, only taking the Palace Museum as the case study object, which cannot accurately and completely represent the Chinese museum industry as a whole.

As for the above limitations, the researcher believes that the study is mainly deepened from the following two aspects: First of all, keep up with the development of technology and application in the museum field, explore back and forth constantly updated technologies, theories, and practices, to supplement, improve, and study the museums in the future. Secondly, it needs to expand the scope of case studies and obtains more accurate data on the transformation of the smart museum for conducting more comprehensive and systematic optimization of the research.

Therefore, this research still has the possibility of improvement, which explores back and forth in the constantly updated technology, theory and practice, keeps up with the characteristics of the times, and continues to supply, improve and study the development of the smart museum.

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