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Exploration of Digital Business Ecosystem Model for Museums Systems to Enhance Co-creation Innovation

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Abstract This study examines how Digital Business Ecosystems (DBEs) can enhance co-creation within Cultural and Creative Industries (CCIs), focusing on the role of museums. As cultural mediators, museums connect creative designers with buyers in a customer-centric market. By integrating digital resources, DBEs foster innovation and collaboration. Through case studies and expert interviews in mainland China and Taiwan, the research assesses DBE strategies for museum development. Findings highlight DBEs' importance in resource integration, innovation, and cross-domain collaboration, offering valuable insights for policymakers, museum practitioners, and stakeholders and advancing knowledge in this field.

Keywords Cultural and Creative Industries, Digital Business Ecosystem, Museum, Digital Transformation, Co-creation

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1. Introduction

This article explores the potential of Digital Business Ecosystems (DBEs) to enhance co-creation within Cultural and Creative Industries (CCIs), focusing on museums' role in facilitating co-creation cooperation in CCIs. Museums, as curators and custodians of art and cultural articles, and serve as crucial mediators between creative designers (CCers) and buyers. The digital transformation within CCIs brings significant opportunities for integrating resources and addressing co-creation challenges through DBEs.

DBEs transcend traditional industry boundaries, fostering open collaboration and competition (Sanyo et al., 2019). For organizations, DBEs offer a strategy to harness resources across varied industries, addressing customer needs. DBE extends Moore's (1993) concept of the business ecosystem, emphasizing digital technology's role. While the business ecosystem underscores organizational interdependencies, DBE amplifies this notion of digital technology's role. This study examines DBE in fostering collaborative and creativity within CCIs.

CCIs require systems supporting products and individual creativity, cultivating co-creation and cross-domain integration (Cunningham, 2002). Encouraging co-creation by strengthening relationships between creative industries and various stakeholders like communities, consumers, suppliers, and other creative sectors foster innovation (Aldianto et al., 2020). DBE align with this, providing digital-driven infrastructure that facilitates seamless interaction and collaboration among diverse entities, including museums, artists, technology providers, and consumers. Exploring DBE's potential in enhancing CCI's collaboration, innovation, and sustainability is essential for the sector's continued growth and success.

Hsu et al. (2023) apply DBE within CCIs, and termed as CCI-DBE model, to enhance creativity and innovation through co-creation mechanisms and technological infrastructure to facilitate seamless resource and knowledge exchange. There are four pillars in the model, stakeholder participation, co-creation mechanisms, consumer experience, and co-created value. This research aims to answer questions: 1) How does the integration of DBE within CCIs enhance practical effectiveness, particularly regarding collaboration and innovation among stakeholders? 2) How can the CCI-DBE model be applied to enhance collaboration and innovation within CCIs, specifically in the context of partnerships between museums and enterprises?

This research focuses on museums in mainland China and Taiwan due to their rich cultural heritage and creative use of digital applications. This study contributes to the academic discourse on DBE and CCIs in museum settings, examining DBE implementation's impact on collaboration, innovation, and cross-domain integration. This research provides insights into leveraging DBE to enhance co-creation initiatives within CCIs and offers practical recommendations for policymakers, museum practitioners, and CCIs stakeholders, advancing knowledge and practice in this field.

2. Cultural and Creative Industries-based Digital Business Ecosystem

The advent of digital transformation presents new opportunities in response to the evolving demands for content and knowledge within CCIs. Chang et al. (2015) assert that digital technology can foster cultural industry cross-brand equity, streamline design and marketing processes, and facilitate a deeper understanding of consumer preferences through interactive engagement, thereby fostering cultural experimentation. Post-digital transformation, CCIs can leverage digital tools to enhance collaboration, co-creation, and co-design capabilities, facilitating cross-domain resource integration and value creation with stakeholders (Ramaswamy & Ozcan, 2014). The construction of virtualized platforms serves to connect ecosystems, thereby amplifying and embodying the experiential value, thus enriching wealth, welfare, and well-being within the industries (Ramaswamy & Ozcan, 2014).

In recent years, numerous enterprises have embarked on constructing DBE as part of their digital transformation initiatives. This move aims to mitigate costs associated with research and development, communication, sales, and risks, while simultaneously enhancing product innovation and service quality. Leveraging the benefits of DBE, CCIs stand to attain improved solutions for enhancing their co-creation mechanisms. Galateanu and Avasilcai (2014) assert that "co-creation is always a joint and mutual process," fostering the exchange of diverse experiences, enriching customer interactions, and adding value to context and interaction. Therefore, the central premise of this research is that digital transformation presents CCIs with new opportunities and challenges, and establishing a DBE can effectively address the shortcomings in co-creation processes within the sector.

Because of its ability to facilitate resource sharing and information exchange, the core functioning of a DBE holds promise in tackling longstanding structural and technical obstacles prevalent in the cultural and creative industries (Ouyang et al., 2012). Hsu et al. (2023) have outlined four key elements essential for constructing the CCI-DBE model, which encompass "Participation of Multiple Stakeholders," "Mechanism of Co-creation," "Uniqueness of Customer Experience," and "Output of Co-created Value". Therefore, the article will continue to use the frame for further case studies.

3. Museum Innovations within the Digital Business Ecosystem

Museums face numerous challenges in digital transformation. The primary challenge lies in the integration of technology with cultural creativity, as many cultural heritages are unique and complex, making straightforward digitalization difficult (Parry, 2007). However, the DBEs provide new perspectives and tools for the commercial digitalization of museums. By proactively exploring and leveraging the potential of DBEs, museums can enhance operational efficiency and offer richer and more personalized cultural experiences for visitors.

Museums, as a crucial component of the cultural and creative industries, have actively embraced the principles of DBEs to advance their commercial digitalization processes. Literature indicates that the digitalization of museums is not confined to the traditional digital display of exhibits but involves the creation of interactive platforms that include a range of stakeholders. For instance, museums can integrate a variety of business functions such as ticketing systems, membership services, and online stores through DBEs platforms, thus creating new revenue streams (Tallon, 2008).

Studies suggest that a successful digital business ecosystem for museums should be flexible and open to adapt to rapidly changing technological environments and user demands. For example, Falk and Dierking (2018) propose that museums should consider user experience and data-driven personalized services in platform design to enhance visitor engagement and satisfaction. By collaborating with other cultural institutions, educational entities, and commercial partners, museums can build a multidimensional digital ecosystem that promotes resource sharing and knowledge dissemination (Falk & Dierking, 2018).

4. Research Methods

This research employs thematic analysis to examine the qualitative data gathered from multiple sources, including selected museum case studies, expert interviews, and relevant documents (Tellis, 1997). Museums included are the Palace Museum in Beijing (PMB), the National Palace Museum in Taipei (NPMP), the Chimei Museum (CM), and the Dunhuang Art Museum (DAM). This method will allow us to identify, analyze, and interpret recurring patterns and themes within the data related to the utilization of DBEs in CCIs.

Our thematic analysis will focus on uncovering insights about how these museums use DBEs to facilitate interactions among creators, museums, and buyers in the CCI. We will pay particular attention to themes related to the 4 pillars of CCI-DBE (Hsu et al., 2023), including the participation of multiple stakeholders, mechanism of co-creation, unique customer experience, and output of co-value. This approach will enable us to systematically organize and interpret the data and portray key concepts and practices that reveal how DBEs boost co-creation mechanisms and contribute to CCI. Figure 1 depicts the process of the study.

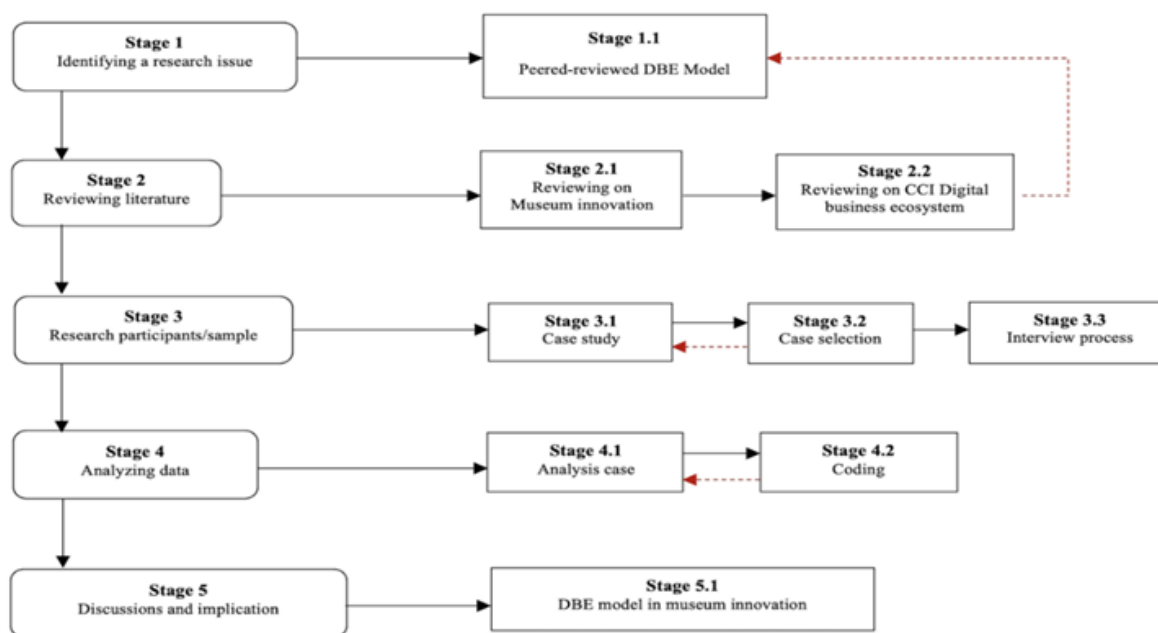


Fig 1. Research Flow (by authors)

4.1 Case Study and Data Analysis Method

In this article, a multiple-case design is applied to strengthen the results through pattern-matching (Yin, 1993) and induce process characteristics. This approach allows for a more comprehensive exploration of research questions and facilitates theory development (Heale & Twycross, 2018; Stake, 2013). This study employs a case study methodology focusing on interviews with from various sectors. The interviewees are experts in CCI from both Taiwan and China, representing a diverse range of roles and perspectives. They include museum curators, scholars, artists, and government agency representatives. This broad selection of interviewees aims to provide comprehensive insights into the CCI sector, covering viewpoints from government, research, and industry professionals.

The in-depth interviews aim to analyze the multifaceted roles of museums within DBEs in the cultural and creative industries. Through firsthand insights gathered from interviews, this research seeks to uncover how museums leverage DBEs to enhance operational efficiency, visitor experience, and cultural dissemination (Creswell, 2014; Yin, 2014). The context-specific approach of conducting interviews allows for a comprehensive understanding of practical operations and challenges faced by museums in their engagement with DBEs. By extracting successful factors and experiences across different contexts, this study aims to provide valuable references for other cultural and creative institutions (Merriam, 2009; Stake, 1995). The flexibility of interview data collection ensures a rich and varied dataset, enhancing the reliability and accuracy of research findings. Comparative analysis based on interviews with museum leaders, academic researchers, and government officials will shed light on the implementation paths of DBEs across different organizational contexts, offering insights into commonalities and discrepancies (Eisenhardt, 1989). Ultimately, the utilization of interviews with key stakeholders will generate practical and theoretical insights, contributing to the development of new frameworks and actionable recommendations for museums and cultural institutions involved in DBE.

4.2 Case Selection

In accordance with Dalle Nogare and Murzyn-Kupisz (2021), museums serve as catalysts for innovation and growth, particularly through their interactions with other CCIs. The selection of cases for this research centers around the core features of the DBE system: a strong intent to expand impacts through cooperation with other industry members, sound initial digital infrastructure and experiences, sufficient resources to support operations, and comprehensive collections. The key features of the system—digital, business, ecosystem (bio-cooperative), and stakeholders (museums, creative creators, and business entities)—guide our case selection process.

The selection of these cases is based on the following criteria:

1. Strong intent for collaboration: Actively seeking partnerships.
2. Robust digital infrastructure: Leveraging innovative technologies.
3. Sufficient resources: Financial and human resources to support initiatives.
4. Comprehensive collections: Extensive and diverse cultural heritage.
5. Global recognition: Symbolizing rich cultural heritage.
6. Representation of cultural identity: Showcasing unique traditions.
7. Innovative practices: Pioneering new approaches.
8. Visitor engagement: Enhancing audience experiences.

Based on the criteria, this research chose four distinguished institutions as the cases to be studied for the DBE-CCI: The Palace Museum in Beijing (PMB), the National Palace Museum in Taipei (NPMT), the Chimei Museum (CM), and the Dunhuang Art Museum (DAM). The first two are state-owned museums, whereas the next two are in the private sector. These museums demonstrate a strong intent for collaboration, possess robust digital infrastructure and extensive experience crucial for DBE implementation, and have ample resources for sustainability. Their diverse collections provide rich content for digital transformation, ensuring relevance across various cultural artifacts. Global recognition and unique cultural identities engage diverse audiences, emphasizing cultural dissemination. Pioneering innovative practices offer insights into integrating new technologies, supporting the study's objectives. Their success in visitor engagement validates their selection for examining how DBEs can facilitate exchanges between museums, creators, and buyers, meeting stakeholders' goals.

4.3 Sample Cases and Comparison

As public institutions, museums have implemented numerous reforms during the digital transformation phase, including the creation of "digital archives" and "open data." Amid the pandemic, these accessible resources have provided the public with easier access to museum content, bridging the gap between cultural relic collections and the general public. Consequently, the four cases examined in this study should demonstrate their successful co-creation efforts with other organizations following their digital transformation.

4.3.1 National Palace Museum Taipei

Since its establishment, the National Palace Museum has been crucial in preserving and showcasing Chinese cultural heritage. Housing over 700,000 artifacts (National Palace Museum, NPMT, 2024), it is one of the largest Han Chinese culture and art museums globally and a world-renowned cultural landmark.

The museum attracts millions of visitors annually and, in 2014, generated NT\$820 million from cultural and creative products, surpassing ticket sales revenue (NT\$750 million) (NPMT, 2014). This success underscores its effective transformation in the cultural and creative industries. By digitizing artifacts and using these digital resources for exhibitions and education, the museum has expanded its influence.

4.3.2 Palace Museum, Beijing

Since its establishment, The Palace Museum has been a cornerstone in preserving and showcasing Chinese cultural heritage. As one of the world's most renowned museums, it houses over 1.8 million artifacts, including paintings, ceramics, bronzes, and jade pieces, establishing it as an international cultural landmark (Zhao, 2019). In recent years, the Forbidden City has seen a surge in visitors, with 17 million visitors in 2018, increasing to 19.3 million in 2019, an increase of 1.8 million from the previous year. At the beginning of 2018, the Forbidden City disclosed that its total sales of cultural and creative products reached 1.5 billion RMB in 2017 (The Palace Museum, PMB, 2024). Its extensive collection and global influence have cemented its prestigious status in the international museum community.

4.3.3 Dunhuang Art

Since its establishment, the Dunhuang Art Institute in Beijing's Tongzhou District has focused on researching, preserving, and promoting Dunhuang art. Renowned for its collections of murals, sculptures, and manuscripts, the institute plays a vital role in protecting this cultural heritage while fostering contemporary applications.

Aligned with its mission, the Dunhuang Art Institute created the "Heritage-as-a-Platform" (Haap) with private companies to boost visibility, co-creation, and industry connections. Recently, the institute has prioritized digital products and services, including ventures into the metaverse and non-fungible tokens (NFTs), increasing the commercial and creative value of Dunhuang art (Dunhuang Art, 2022a, 2022b).

The Dunhuang Art Institute's blend of traditional art and modern technology, resulting in commercial success and global audience engagement, makes it an excellent case study for social research. This approach demonstrates a viable model of cultural heritage preservation intersecting with profitable ventures, ensuring the relevance and appreciation of Dunhuang art in the modern world.

4.3.4 Chimei Museum

Since its establishment in 1992, the Chimei Museum in Tainan has been pivotal in preserving and promoting diverse cultural heritage. It houses over 4,000 European paintings and sculptures, and over 1,000 musical instruments (Chimei Museum, 2024), attracting millions of visitors annually, including over 1.1 million in 2019 (Chimei Museum, 2019).

The Chimney Museum has adopted virtual tours, interactive exhibits, and ventured into the metaverse and NFT to enhance its global reach and visitor engagement, and has been experimenting and refining its technology on digital infrastructure and innovation since 2017 (Chimei Museum., 2017). The sale of digital collections and virtual experiences has created new revenue streams, showcasing the profitable fusion of traditional art and modern technology.

Additionally, the museum markets creative cultural products through partnerships, boosting its commercial value. Its commitment to public education and collaboration with academic institutions for research underscores its importance in scientific and social studies. Overall, the Chimei Museum exemplifies the integration of cultural preservation with profitable digital ventures, ensuring its relevance, financial viability, and appreciation in the modern era.

4.3.5 Cooperative activities with museums

We compiled cases of collaboration with external institutions to analyze how cultural institutions establish connections between industries, create a DBE environment, and enhance their influence (Table 1). All of the case museums have digital archives and collaborate with various agencies to develop special activities, services, and products. For example, the Palace Museum partners with technology companies like Tencent and Dingding to develop apps and programs that enhance the visitor experience. Similarly, the National Palace Museum collaborates with HTC to create a VR version of "Along the River During the Qingming Festival," and the Chimei Museum develops real escape games.

Table 1. List of forms of museum cooperation and co-creation (constructed by this study)

Museums	Stakeholders	Cooperation	Co-creative values
Palace Museum (Beijing)	Institutions for academic research	Research	Heritage preservation and knowledge enhancement
	Tencent	Cooperative development	Digitalization of cultural relics/Expansion of experience space (virtual and real integration)/Expand the scope of interaction
	Dingding Technology	Cooperative development	Internal digital management/Promote the construction of smart museums/Permanent preservation and sustainable inheritance of cultural heritage
	Kander's Art	Cooperative development	Innovative application of traditional cultural relics (development of cultural relics NFT)
National Palace	CCers	Authorization	Reciprocity and mutual benefit
	HTC VIVE Arts	Cooperative	Immersive interactive experience entertains and

Museums	Stakeholders	Cooperation	Co-creative values
Museum (Taipei)		development	educates. Create humanistic and artistic literacy, cross-border applications, and expand social value.
	Nintendo Switch	Cooperative development	Enable game players (audiences) to interact with cultural relics and expand application value
Dunhuang Art	Samsung	Cooperative development	Innovative application
	Yueguan Art	Cross-industry alliance	Derivative work
	hellorf.com	Platform calls for original designs	Active creativity
	CCers	Build co-creation platform	Heritage-as-a-Platform: Improve the popularity of the art industry, create a co-creation platform, and connect industrial resources
Chimei Museum	CCers	Brand authorization	Reciprocity and mutual benefit
	Clubon	Cooperative development	Innovate customer experience/Cultural relics immersive interaction
	How online course	Cooperative development	Aesthetic experience diffusion
	AUO Corporation	Technical cooperation	Technology improves the accessibility of art and increases the quality of audience experience
	public television	Cooperative development	Dissemination, educational value

4.4 Experts Interviews

The research involved engaging in discussions with four experts to assess the feasibility of implementing the DBE model in the industry and to delve into the collaborative dynamics between museums and allied institutions. These experts, selected from both mainland China and Taiwan, brought diverse backgrounds to the table, including individuals from government cultural departments, founders of cultural organizations, and scholars specializing in cultural industries and technology applications. Each interview followed a structured format, focusing on current challenges in CCIs and the experts' perspectives on DBE strategies. Based on their responses, additional questions were tailored to their individual interests and insights. The interviews, lasting approximately ninety minutes each, began with providing interview outlines to the participants to guide the discussion and facilitate thorough preparation.

In this study, productive discussions were held with four distinguished experts to assess the effectiveness of implementing the DBE model within the industry and explore collaborative dynamics between museums and allied institutions (Table 2). The panel of experts, carefully chosen from both mainland China and Taiwan, brought forth a diverse range of perspectives, including governmental cultural authorities, prominent figures from the artistic realm, and esteemed scholars specializing in cultural industries and technological applications. Each meticulously crafted interview session focused on pressing challenges encountered within CCIs and museums, delving deep into the nuanced insights of the experts on DBE strategies. Tailored follow-up inquiries were utilized to uncover the unique perspectives of each interviewee.

Table 2: Interviewees

Name	Title	Interview Duration	Method	Invite Reasons
Lin	Deputy Director General of Government Cultural Departments	90 minutes	Personal interview	Representative of government sector, expertise and knowledge of policy insights, cultural dissemination, heritage preservation, and public project advocacy.
Zhang	Founder of Artistic Organizations	90 minutes	Personal interview	Representative of industry operation, expertise in art, strategic insight, cultural heritage preservation, and extensive experience.
Li	Associate Dean of Dunhuang Art	90 minutes	Visual interview	Representative of industry operation, expertise in art, strategic insight, cultural heritage preservation, and extensive experience.
Liu	Scholars From Universities	90 minutes	Visual interview	Representative of academic research Published numerous research on the cooperation of the role of museum in the CCI development, expertise in the field, cutting-edge research, academic depth, and educational perspectives.

4.5 Interview process

The interview sessions, each lasting approximately ninety minutes, began by providing comprehensive outlines to stimulate focused discussions and thorough preparation. In every interview, whether conducted in person or visually, we obtained consent to retain audio recordings and diligently documented notes. After posing each question, the interviewer ensured alignment of understanding by listening to the interviewee's response first and then restating the meaning if necessary. Following the interviews, the authors individually reviewed and exchanged notes to guarantee the accuracy and comprehensiveness of the information. Once confirmed, the note-taker signed the note sheets to signify agreement.

4.6 Reliability and validity

The reliability and validity of the research in this study were ensured through rigorous measures. Reliability was maintained through detailed interview outlines, structured format for interviews, and complete record-keeping of audio recordings and notes. Notes were cross-checked among authors, with a third author mediating discrepancies, ensuring verification (Yin, 2014). Validity was assured by having experts review interview questions and data collection instruments, grounding constructs in existing literature, and employing member checking by sharing findings with interviewees for validation. Additionally, cross-verification with multiple data sources ensured accurate and comprehensive coverage. These measures collectively enhanced the credibility and robustness of the findings (Yin, 2014).

5. Result Analysis

The establishment of DBEs within the digital transformation process offers CCIs opportunities to enhance their co-creation mechanisms (Galateanu & Avasilcai, 2014). While previous research has contributed theoretical models of CCI digital business ecosystems (Hsu et al., 2023), this study aims to examine real cases to uncover the practical value of the CCI DBE concept, addressing a gap in the current literature.

5.1 Integrate the Contributions of Multiple Stakeholders within the CCI-DBE Model to Promote Museum Intellectual Property

Museums must actively promote their intellectual property (IP) to attract more visitors (Chen, 2020), utilizing the CCI-DBE model to revitalize museum IP and establish a sustainable cultural and creative content industry. This goal

can be achieved through the effective involvement of cross-sector stakeholders. For example, the NPMT collaborated with technology companies like HTC to create virtual reality experiences such as "Along the River During the Qingming Festival," which bring historical artifacts to life and provide immersive educational experiences (Cris, 2019), while also attracting the younger generation through innovative methods that drive strong sales (LaVie, 2015). PMB organized the "NEXT IDEA" competition in 2019 to promote the integration of traditional culture and digital creativity, gathering CCers. Additionally, the Palace Museum collaborated with external institutions, notably working with Tencent to develop the "Digital Palace Museum Mini Program," which combines online and offline features to offer an innovative visiting experience. China Mobile involved technology companies to develop digital experiences that attract young audiences. For instance, in collaboration with Clubon, they used VR games and interactive exhibits to create engaging visitor experiences. Moreover, they partnered with educational institutions to develop projects that integrate digital technology into learning, making it easier for students to access art and history. Furthermore, Dunhuang Art engaged in cross-industry collaborations with companies like "Shenhuan," "Mingquan Culture," and "d-arts.cn" to combine digital and traditional art forms, fostering innovation and brand development. The active participation of diverse stakeholders in these initiatives has driven the promotion of museum IP and the sustainable development of the cultural and creative content industry.

Proposition 1: Cross-domain stakeholders bring diverse expertise while sharing a unified belief/ commitment to the core content.

5.2 Leveraging Technology for Co-Creation Mechanisms in Museums within the CCI-DBE Model

Museums can establish co-creation mechanisms with stakeholders by leveraging technology and fostering collaborative efforts. Recently, museums have reformed in response to the establishment of digital archives and open data, enhancing public access to resources and bridging the gap between cultural artifacts and the public, especially during crises such as pandemics. Core values like content, active engagement, cross-sector collaboration, audience cultivation, and sustainable strategies are crucial in this process. For instance, the NPMT digitizes its collection and collaborates with stakeholders to create innovative cultural products, supported by comprehensive databases for commercial use. Similarly, PMB enhances its digital cultural relics database through technology partnerships with companies like Tencent, developing integrated online and offline experiences. Additionally, CM engages artists and CCers with its collections, authorizing the creation of diverse products and performances. DAM's Heritage-as-a-Platform (HaaP) initiative, developed with private companies, merges traditional art with modern technology, boosting the art industry's popularity and facilitating co-creation. These efforts illustrate how museums can leverage digital tools and collaborative strategies to effectively promote cultural heritage and engage a broader audience.

Proposition 2: Digital transformation promotes the establishment of a cooperation platform, and supporting this platform requires both knowledge and technology.

5.3 Enhancing Unique Customer Experience and Museum Engagement through Technological Innovation in within the CCI-DBE Model

Museums are enhancing audience interaction through diverse technological applications within the CCI-DBE Model, moving beyond passive exhibition displays to actively engage their visitors by cultivating cultural affinity. Strategies include adopting user-centric approaches with integrated digital technologies, continuous innovation through user feedback, and the strategic use of modern technologies such as VR, AR, and digital platforms to create interactive and immersive cultural experiences. For instance, the NPMT initiated the digitization of cultural relics in 2002, enhancing user experience and accessibility through commercial collaborations like that with Nintendo Switch (LaVie, 2015). The PMB developed the Digital Palace Mini Program with Tencent, offering innovative experiences by integrating online and offline functionalities and creatively displaying cultural relics to enhance engagement. CM employs virtual reality games for interactive exhibits, making art more accessible and enabling deeper audience engagement. Additionally, DAM's HaaP initiative collaborates with private companies to boost the art industry's popularity, focusing on innovative digital products like metaverses and NFTs while providing unique cultural experiences through VR interactions. These initiatives demonstrate how museums leverage technology within the CCI-DBE Model to create unique customer experiences, ensuring sustained visitor engagement and appreciation for cultural heritage.

Proposition 3: Enhancing unique customer experience and museum engagement through technological innovation within the CCI-DBE model demonstrates that customer experience can be valued and become an integral part of content creation in CCIs.

5.4 Maximizing Co-Value through Digital Business Ecosystems (CCI-DBE)

This study underscores the pivotal role of DBEs within the CCIs, akin to natural ecosystems, in enhancing resource integration and industry co-creation. Collaboration among diverse stakeholders is emphasized in creating customer value, with successful outcomes often stemming from partnerships with a variety of entities and the exploration of multiple avenues. In this value network, collaborative efforts contribute to meeting customer demands. The approach leverages the core ecosystem principle of "co-evolution," where various partners engage in collective evaluation to realize a shared vision. Initiatives like the integration of cultural collections into popular media, such as the partnership between the National Palace Museum and Nintendo Switch for "Animal Crossing New Horizons (ACNH)," demonstrate how museums are broadening audience reach and engaging with younger demographics. Similarly, collaborations with platforms like Tencent and innovative strategies like the "Myth of Allegories" reality game by Chimei Museum are reshaping visitor experiences, making cultural heritage more accessible and immersive. The pioneering HaaP concept by Dunhuang Art showcases successful commercial ventures with NFTs and novel cultural applications, reflecting digital productivity growth and increased commercial reach within the CCI. Museums collaborate with stakeholders through the CCI-DBE model to enhance intellectual property and establish sustainable cultural industries. By leveraging technology, cross-sector partnerships, and enhancing visitor experiences, museums broaden their audience and drive innovation. The dynamic business ecosystems foster value creation and industry evolution within the cultural and creative sectors.

Proposition 4: The co-evolution of all stakeholders within a DBE allows smaller studios to grow collectively. These dynamics impact the diversity and scale of CCIs, potentially hindering the overall prosperity of the industry.

5.5 Thematic Analysis and Digital Business Ecosystems Model

Our study systematically investigates the DBE model's impact on museums. To conduct this analysis, we used thematic analysis to categorize and encode the data, which allowed us to draw out key propositions and construct our model (Table 3). This approach ensured that the findings were rigorously derived from the data and aligned with our research objectives.

We identified four key propositions through this thematic analysis.

Proposition 1 posits that cross-domain stakeholders bring diverse expertise while sharing a unified belief and commitment to the core content. Our findings indicated that effective stakeholder collaboration enhances intellectual property promotion and drives innovative engagement strategies. The collaboration between museums and technology companies, for example, highlighted in our case studies of the National Palace Museum Taiwan (NPMT) and the Palace Museum Beijing (PMB), exemplifies how diverse parties can transform core content through digital creativity.

Proposition 2 highlights that digital transformation promotes the establishment of a cooperation platform, requiring both knowledge and technology for support. Our analysis revealed that such platforms allow stakeholders to exchange knowledge and technological resources effectively, fostering innovation and creative development. For instance, museums using digitization to preserve cultural heritage while engaging with new digital tools illustrate how technology supports co-creation.

Proposition 3 asserts that enhancing unique customer experience and museum engagement through technological innovation within the CCI-DBE model demonstrates that customer experience can be valued and become an integral part of content creation in CCIs. Our data showed that digital innovations, such as virtual reality (VR) and interactive exhibits, significantly enhance visitor interaction and engagement, providing a unique experience that involves user feedback. This was evident in the Chimei Museum (CM) and Dunhuang Art Museum (DAM), where VR games and other immersive technologies deepened visitor engagement.

Proposition 4 suggests that the co-evolution of all stakeholders within a DBE allows smaller studios to grow collectively, impacting the diversity and scale of CCIs. This collective growth fosters a diverse and innovative environment but also highlights potential challenges in maintaining the overall prosperity of the industry. Our findings demonstrated that smaller studios could leverage the collaborative framework of DBEs to grow, as seen in DAM's partnerships, but this growth needs to be managed to ensure sustainable industry development.

Based on these propositions and findings, we constructed a comprehensive model that visually represents the integration and interactions within the CCI-DBE framework. The model places core content at the center, supported

by multiple stakeholders' participation, mechanisms of co-creation, unique customer experiences, and the output of co-value.

Table 3. Thematic Analysis Structure: From Codes to Propositions in CCI_DBE

Propositions	Findings	Themes	Codes
Proposition 1: Cross-domain stakeholders bring diverse expertise while sharing a unified belief/ commitment to the core content.	Finding 1.1: Effective stakeholder collaboration enhances IP promotion/ sharing a unified belief to the core content.	Shared Vision	Diverse expertise, Core content, Unified belief, Collaborative strategies
		Cultural Integration	Cultural value, Heritage promotion, Artistic collaboration, Educational impact
	Finding 1.2: Cross-industry partnerships drive innovative engagement strategies.	Cross-domain Stakeholders	Diverse parties, Innovative games, Digital creativity, Resource sharing
		Strategic Alliances	Partnerships, Joint ventures, Collaboration networks, Industry support
Proposition 2: Digital transformation promotes the establishment of a cooperation platform, and supporting this platform requires both knowledge and technology.	Finding 2.1: Shared a cooperation platform that stakeholders can exchange knowledge and technology resources.	Technology and Platform Support	Digital tools, Technological resources, Platform development
		Knowledge Exchange	Information sharing, Expertise transfer, Collaborative learning, Innovation sharing, Knowledge exchange
	Finding 2.2: Alignment in core content vision leads to innovation and creativity development.	Digital Transformation	Technological advancement, Digital adoption, Process digitization, Innovation integration
		Innovation Ecosystem	Network of innovators, Supportive infrastructure, Collaborative environment, Creative development
Proposition 3: Enhancing unique customer experience and museum engagement through technological innovation within the CCI-DBE model demonstrates that customer experience can be valued and become an integral part of content creation in CCIs.	Finding 3.1: Digital innovation enhances visitor interaction and engagement.	Digital Displays	Interactive screens, Visual content, High-tech exhibits, Digital storytelling
		Engagement Strategies	Innovative methods, User involvement, Audience retention, Experience enhancement
	Finding 3.2: User-centric approaches and prompt market feedback	Unique experience	Personalized content, User feedback, Custom experiences, Tailored interactions
		Market Feedback	Real-time feedback, Customer insights, Data-driven improvement, User satisfaction
Proposition 4: The co-evolution of all stakeholders within a DBE allows smaller studios to grow collectively. These	Finding 4.1: Co-evolution fosters collective growth of smaller studios.	Collective growth	Co-evolution, Collaboration, Industry support, Studio development
		Industry Mentorship	Guidance, Knowledge transfer, Experience sharing, Professional development

dynamic impacts the diversity and scale of CCIs, potentially hindering the overall prosperity of the industry.	Finding 4.2: Diverse collaborations impact the scale and diversity of CCIs.	Industry diversity	Diverse partnerships, Innovation, Market scale, Inclusive growth
		Market Scale	Industry expansion, Market reach, Growth strategies, Economic impact

Through the interview and case study, we modified CCIs DBE model (Fig 2). In this model we propose four elements of industrial cooperation. First of all, we emphasize the need for diverse participants, which is different from the past model in which institutions went it alone. These participants share a common belief that makes them willing to share resources and expertise in content creation. Second, digital transformation promotes the establishment of a cooperation platform, and supporting this platform requires both knowledge and technology. This is also a co-creation method that was rarely mentioned in previous CCIs research. Only after the digital transformation can we have the opportunity to build a platform which can broaden multiple applications of digital archive. Third, customer experience can be valued and become a link in the content creation of CCIs, which was hardly advocated in previous exhibitions. In the DBE model, the two-way interaction between exhibitions and customers will become one of the main strategies to exert the museum's influence. Finally, all stakeholders in DBE can co-evolve, which is a concept that the CCIs industry lacked in the past, which led to the lack of leading cultural institutions in Taiwan and the mainland CCIs leading smaller studios to grow together. This will impact the diversity and scale of CCIs, making it impossible for the industry to prosper.

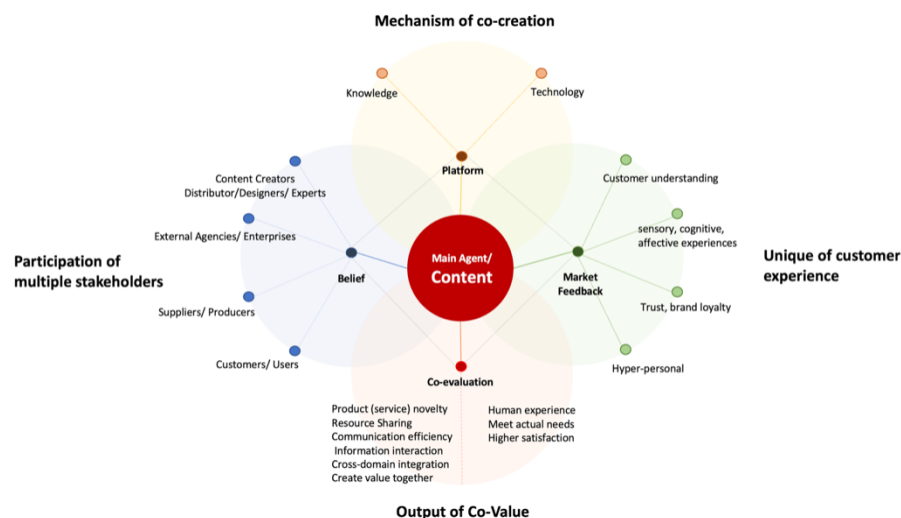


Fig 2. Modified CCIs Digital Business Ecosystem Model

6. Discussions and Implications

DBE represents a collaborative space comprising diverse entities engaged in value co-creation facilitated by information and communication technologies (ICTs) (Nachira et al., 2007). Given its characteristics of resource sharing and information interaction, DBE addresses traditional structural and technical challenges encountered by CCIs (Ouyang et al., 2012). By transcending conventional industry limitations, DBE promotes open and adaptable cooperation and competition, offering organizations a pioneering method to harness resources from various sectors to meet customer demands effectively (Senyo et al., 2019). Particularly within CCIs, where products and services hold symbolic meaning and value, innovation and co-creation are paramount to address the unique demand dynamics (Yang & Černevičiūtė, 2017; Aldianto et al., 2020).

7. Conclusions

In conclusion, this research has shed light on the transformative potential of DBEs within the context of CCIs, with a specific focus on museums. By examining case studies and engaging with experts, we have elucidated the critical role of DBEs in fostering collaboration, innovation, and sustainability within the museum sector. Through the CCI-DBE

model, museums can harness digital technologies to establish dynamic networks, enhance audience engagement, and co-create value with diverse stakeholders. The findings underscore the importance of embracing digital transformation and adopting collaborative strategies to navigate the evolving landscape of CCIs. Moving forward, continued research and practical implementation of DBEs in museums and other cultural institutions hold promise for driving growth, fostering creativity, and enriching cultural experiences for global audiences.

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