

## Exploring digital art's role in cultural product innovation in northeast China's industrial base

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**Abstract:** This research investigates the impact of digital art on the innovation of cultural and creative products, particularly in Northeast China's historical industrial regions. It explores how digital art enhances product design and functionality, ultimately improving market competitiveness. Data was collected via a questionnaire survey targeting employees in these regions, with SEM used to analyze the relationships between digital art, product innovation, and market competitiveness, focusing on the mediating role of product innovation. The results reveal that integrating digital art significantly enhances market competitiveness by advancing technology, enriching design aesthetics, and aligning products with market demands. Product innovation is identified as a key mediator in this process, underscoring digital art's essential role in the development of cultural and creative products. The study concludes that digital art not only boosts the artistic quality and market appeal of these products but also drives continuous innovation, positioning it as a vital force in the cultural industry's growth. As technology advances, digital art is expected to become increasingly influential in shaping the future of cultural and creative sectors.

**Keywords:** Cultural and creative products, Digital art, Market competitiveness, Old industrial base in Northeast China, Product innovation.

### 1. Introduction

In the current age of swift globalization and digital transformation, the cultural and creative sectors have emerged as a crucial driver of economic development, drawing significant interest from both governments and communities around the globe [1]. Digital art, as an emerging art form, is gradually becoming a crucial tool for developing cultural and creative products [2]. It not only revolutionizes the forms of traditional art but also endows cultural and creative products with more innovation space and market value [3]. The use of digital art involves blending artistic creativity with technology through various digital platforms like virtual reality, augmented reality, digital animation, and digital painting, which modernizes both the methods of artistic expression and presentation [4]. Due to technological progress, digital art has evolved beyond a mere art form to become a crucial element in fostering innovation within cultural and creative products [5]. The unique aspect of digital art lies in its ability to break the limitations of traditional art media, making artistic creation more flexible and diverse [6]. Moreover, the interactive and immersive qualities of digital art have introduced novel user experiences to cultural and creative products, boosting their attractiveness and market competitiveness [7].

In the evolution and advancement of cultural and creative products, innovation plays a vital role [8]. Product innovation involves not only the renewal of creativity and design but also improvements in functionality and enhancements in market adaptability [9]. Integrating digital art offers a wealth of creative resources and technical backing for product innovation, allowing cultural and creative products to more effectively cater to the demands of contemporary consumers [2]. For instance, through digital art, traditional crafts can be endowed with new visual effects and interactive functions, cultural heritage

can be virtually recreated through digital technology, and new cultural symbols and brand images can even be formed.

Market competitiveness of cultural products encompasses the advantages that cultural and creative products hold in the marketplace, such as sales performance, consumer interaction, and brand visibility [10]. As consumer demand for cultural experiences grows, cultural and creative products that combine distinctive creativity with advanced technology are more likely to excel in the marketplace [11]. Digital art, as a significant driver of innovation in cultural and creative products, significantly enhances market competitiveness through its application in product design, user experience, and market promotion [12]. For example, immersive experiences and interactive content created using digital technology can attract more consumer participation, enhancing brand recognition and loyalty [13].

In Changchun, as one of the old industrial bases in Northeast China, the development of the cultural and creative industries has a unique historical and cultural background [14]. As an important industrial city in China, Changchun achieved remarkable economic success in the mid-20th century through heavy industry and manufacturing [15]. However, with the changes in the global economic environment and the adjustment of the domestic industrial structure, traditional industrial cities are facing challenges in transformation and upgrading. Amidst this context, the Changchun region is proactively exploring the growth of its cultural and creative industries by leveraging digital art to drive the evolution of cultural and creative products. This approach not only injects fresh energy into the city's economic transformation but also introduces innovative methods for preserving and promoting local culture [16]. The development of cultural and creative products in the Changchun region makes full use of the area's abundant cultural resources and industrial heritage, including old factory buildings, industrial facilities, and traditional crafts. These elements are incorporated into contemporary cultural and creative products through the use of digital art forms [17]. For example, old factory buildings have been transformed into cultural and creative parks, introducing digital art exhibitions and creative studios, revitalizing traditional industrial heritage [18]. Meanwhile, digital technology is used to develop digital content related to local culture, such as virtual museums and digital restoration of cultural relics, which not only enhances the creativity and interactivity of cultural products but also increases their market value and competitiveness [19].

In conclusion, the use of digital art offers substantial technical support and creative resources for the innovation and growth of cultural and creative products [20]. In the Changchun region, digital art has driven the advancement of cultural and creative products while also boosting their competitiveness in the market. Through the application of digital art, traditional cultural elements are presented in new forms, and the innovation and market appeal of cultural and creative products have been significantly improved. Looking ahead, as technology progresses and the cultural and creative industries expand, digital art will become an increasingly pivotal force in driving innovation within cultural and creative products, infusing new energy into the cultural industry's growth.

## 2. Literature Review

### 2.1. *The Application of Digital Art and Market Competitiveness*

As a new form of artistic and creative expression, digital art is making significant inroads into the cultural and creative industries due to technological advancements and the rise of the digital age, deeply influencing market competitiveness [2]. The application of digital art is not merely a digital transformation of traditional art forms; it is also a novel attempt to create and express art through technological means [4]. Dai's [21] research indicates that incorporating digital art can significantly enhance the diversity of expression and artistic value in cultural and creative products. For example, through the use of virtual reality (VR) technology, audiences can immerse themselves in art, experiencing it as if they were part of the work. This immersive experience not only enhances user engagement and interactivity but also expands the dissemination channels and audience reach of art [22]. In market competition, this new mode of experience enables cultural and creative products to attract more consumer attention, thereby enhancing product market recognition and brand value [23].

Through digital technology, cultural and creative products can overcome geographical limitations, enabling cross-border exhibition and sales, thus expanding their market coverage and market share [24]. From a global perspective, this market competitiveness not only fosters the international growth of cultural and creative industries but also opens up wider opportunities for product innovation and development [25].

*H<sub>1</sub>: The Application of Digital Art Positively Impacts the Market Competitiveness.*

### *2.2. The Application of Digital Art and Product Innovation*

Traditional cultural and creative products frequently encounter obstacles in achieving substantial innovation in design and functionality due to constraints in materials and craftsmanship. However, as an emerging form of creative expression, digital art integrates digital technology, offering new possibilities and creative tools for product innovation [6]. Digital art breaks the constraints of traditional art being limited to flat or physical forms, allowing artworks to be presented in more diverse and three-dimensional ways through technologies like virtual reality (VR) and augmented reality (AR) [3]. For example, AR technology enables artworks to interact with real-world scenes, facilitating real-time interaction between the artwork and the audience. This not only enhances the aesthetic effects of the artwork but also expands its expressive capabilities and methods of dissemination. At the same time, the use of digital art propels innovation in the functionality and practicality of cultural and creative products [26]. As consumers' demand for personalization and customization increases, cultural and creative products are no longer just artworks but also emphasize functionality and practicality [9]. For example, utilizing 3D printing technology and digital simulation design allows cultural and creative products to be customized to cater to the unique preferences of individual consumers, thereby boosting their market competitiveness. Moreover, digital art offers technological support and creative platforms that facilitate innovation in cultural and creative products [5]. Using digital design tools, artists and designers can more easily conduct creative experiments and develop designs, accelerating the innovation cycle and speed to market [27], thereby advancing the digital transformation and intelligent growth of the cultural and creative industries [28].

*H<sub>2</sub>: The application of digital art positively impacts product innovation.*

### *2.3. Product Innovation and Market Competitiveness*

In the highly competitive cultural and creative industries, product innovation serves as a crucial strategy for gaining a market advantage [12]. As market demands and consumer preferences continue to evolve, traditional cultural and creative products often face challenges of homogenization and intensified competition [29]. Therefore, product innovation is crucial for enhancing product differentiation and market appeal. By continuously updating and improving design, functionality, and performance, product innovation enables cultural and creative products to better meet market demands and consumer expectations [7]. For example, adopting new materials, technologies, or design concepts can enhance a product's appearance, quality, and utility, thereby boosting market competitiveness and brand value [11]. Additionally, product innovation can break market deadlocks, avoid homogenized competition, open new markets, and attract new consumer groups [10]. Through continuous innovation, cultural and creative products can achieve broader market recognition and consumer favor, expanding market share and enhancing brand influence. Additionally, product innovation supports the sustainable growth of the cultural and creative industries and helps establish enduring competitive advantages [30]. By maintaining consistent innovation efforts and quickly responding to market feedback, companies can promptly adjust product strategies and market positioning, sustaining market vitality and competitiveness [13].

*H<sub>3</sub>: Product innovation positively impacts the market competitiveness.*

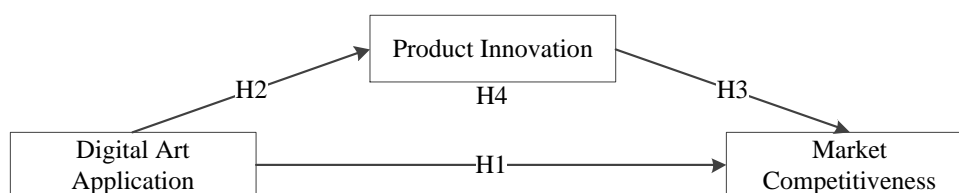
#### 2.4. The Mediating Role of Product Innovation Between the Application of Digital Art and Market Competitiveness

The integration of digital art has enhanced the design language and artistic expression of cultural and creative products [4]. Traditional cultural and creative products are frequently constrained by materials and craftsmanship, making it difficult to achieve breakthrough innovations in artistic expression and visual effects [6]. However, the application of digital art, such as virtual reality technology and digital simulation design, provides new possibilities for product design, allowing products to be presented in more avant-garde and diverse forms, thereby enhancing their artistic appeal and market attractiveness [21]. Moreover, product innovation, driven by technological advancements and functional design, strengthens the market competitiveness of cultural and creative products [11]. The application of digital art not only endows products with new visual impact and interactive experiences but also meets the needs of different consumer groups through customized and personalized design, thereby increasing market adaptability [9]. For example, personalized artworks created using digital technology are more likely to attract young consumers, enhancing the brand's sense of fashion and trendiness, which in turn boosts market competitiveness [11]. Product innovation also accelerates the application and promotion of digital art in cultural and creative products through market feedback and continuous optimization [13].

*H<sub>1</sub>: Product innovation mediates the relationship between the application of digital art and the market competitiveness.*

#### 2.5. Research Model

The Diffusion of Innovations theory describes how innovations spread within a social system [31]. This theory emphasizes five key factors: relative advantage, compatibility, complexity, trialability, and observability, which explain why certain innovations can successfully diffuse and be widely adopted [32]. Based on the Diffusion of Innovations theory, this paper posits that in the cultural and creative industries, digital art, as an innovative technology [22], can quickly spread due to its relative advantage in significantly enhancing visual effects and interactive experiences, as well as its compatibility with existing design processes [23]. Although the initial complexity may be high, this challenge diminishes as the technology matures and training becomes widespread [11]. Through small-scale pilot projects, companies can verify its value with low risk, and the demonstration of successful cases allows other practitioners to intuitively perceive the market competitiveness improvements it brings [9]. This process not only promotes the diversification and high-quality development of products but also strengthens the competitiveness of companies in the market [29]. The Diffusion of Innovations theory offers a crucial framework for understanding how digital art spreads within the cultural and creative industries, aiding in the broad adoption of technology and the improvement of market competitiveness. As shown in Figure 1.



**Figure 1.**  
Research model.

### 3. Research Methods and Design

#### 3.1. Survey Questionnaire

The digital art application scale, based on Paul and Osthoff [33], was modified for content validity to align with the measurement requirements of this study on digital art application. The scale comprises

five dimensions with a total of 20 measurement items, including 4 items for functionality and user experience, 4 items for satisfaction with artistic creation, 4 items for interaction and sharing, 4 items for learning and growth, and 4 items for technical support and services. It uses a 5-point Likert scale. The Cronbach's  $\alpha$  values for the sub-scales ranged between .688 and .872, achieving an overall Cronbach's  $\alpha$  of .857 for the entire scale. The model fit indices were  $\chi^2/df = 2.852$ , RMSEA = .048, GFI = .948, AGFI = .919, and SRMR = .036, indicating the scale's robust reliability and validity.

The product innovation scale, based on DeVellis [34] and Prasada et al. [35], was modified for content validity to measure cultural and creative product innovation in this study. The scale is unidimensional and consists of 7 measurement items, scored on a 5-point Likert scale. The Cronbach's  $\alpha$  for the scale is .903. The fit indices for the model show  $\chi^2/df = 2.620$ , RMSEA = .041, GFI = .954, AGFI = .881, SRMR = .045, and CFI = .923, indicating the scale's strong reliability and validity.

The market competitiveness scale, based on Cappelli and Crocker-Hefter [36] and Prasada et al. [35], was modified for content validity to measure the market competitiveness of cultural and creative products in this study. The scale is unidimensional with a total of 4 measurement items, scored on a 5-point Likert scale. The Cronbach's  $\alpha$  for the scale is .922. The fit indices for the model included  $\chi^2/df = 2.022$ , RMSEA = .044, GFI = .953, and AGFI = .970, reflecting the scale's high reliability and validity.

### 3.2. Research Participants

This study selected employees from the old industrial base in Northeast China as the research participants. According to the sampling guidelines suggested by Ghiselli et al. [37], the sample size should be at least ten times the total number of items in the scales used. Based on this criterion, the study involved three scales with a total of 31 items, requiring at least 310 valid samples. To account for potential invalid questionnaires, the sample size was increased to 350, and data were collected through an online survey using convenience sampling.

The questionnaire collection period was from April to June 2024. After excluding invalid questionnaires due to overly consistent answers, missing responses, or unusually short completion times, the final number of valid questionnaires was 337, resulting in a valid response rate of 96.26%. Regarding the demographic information of the respondents, the gender distribution was 133 males (39.47%) and 204 females (60.53%).

## 4. Results

### 4.1. Common Method Bias

Common Method Bias (CMB) arises from potential correlations among various indicators when the same measurement tool, evaluator, or contextual factors such as time and location are used. This can affect the interpretation and generalizability of research findings. In this study, confirmatory factor analysis was performed using Amos software to evaluate the construct validity of each variable. Initially, a three-factor model, including digital art application, product innovation, and market competitiveness, was proposed. Model fit indices like  $\chi^2$ , RMSEA, CFI, GFI, and NFI were used to assess the model's goodness of fit. As shown in Table 1, the three-factor model demonstrated a good fit, with  $\chi^2 = 776.440$ , RMSEA = .056, CFI = .919, GFI = .907, and NFI = .910. An alternative model, Model 2, which combined the three factors into a single factor, was also evaluated. Comparing the fit indices of both models revealed that Model 1 provided a better fit for the data than Model 2. Burnham et al. [38] introduced a model comparison index:  $\Delta AIC = AIC - AIC_{\min}$ , where  $AIC_{\min}$  represents the smallest AIC value among related models. This approach indicates that the best model has a  $\Delta AIC$  value of 0, with all other models showing positive values. Among a series of candidate models,  $\Delta AIC$  serves as a significant indicator for comparison. The interpretation guidelines for AIC are as follows: when  $\Delta AIC \leq 2$ , the model is strongly supported; when  $4 \leq \Delta AIC \leq 7$ , support is relatively weaker; and when  $\Delta AIC \geq 10$ , the model is no longer supported. For Model 1, the  $\Delta AIC$  value was 0, indicating strong support for the distinctiveness of the three variables analyzed in this study [38].

**Table 1.**  
Multi-factor model analysis.

Model	Factor	$\chi^2$	df	RMSEA	CFI	GFI	NFI	$\Delta AIC$
1	Three-factor	776.440	280	0.056	0.919	0.907	0.910	0
2	Single factor	1890.161	276	0.141	0.758	0.692	0.791	11.667

#### 4.2. Correlation Analysis

The mean value of digital art application was 3.773, with a standard deviation of 0.937, indicating that participants generally rated digital art application highly, with moderate variability in their ratings. The mean value for product innovation was 3.561, with a standard deviation of 0.802, showing that participants also rated product innovation highly, with slightly less variability than digital art application. The mean value for market competitiveness was 3.669, with a standard deviation of 0.824, suggesting that participants' evaluations of market competitiveness were between the other two, with relatively lower variability.

In terms of correlation analysis, digital art application was found to be significantly positively correlated with product innovation ( $\beta = .478$ ,  $p < .001$ ); digital art application was also significantly positively correlated with market competitiveness ( $\beta = .395$ ,  $p < .001$ ); and product innovation was significantly positively correlated with market competitiveness ( $\beta = .446$ ,  $p < .001$ ), providing preliminary support for the research hypotheses.

**Table 2.**  
Correlations between constructs.

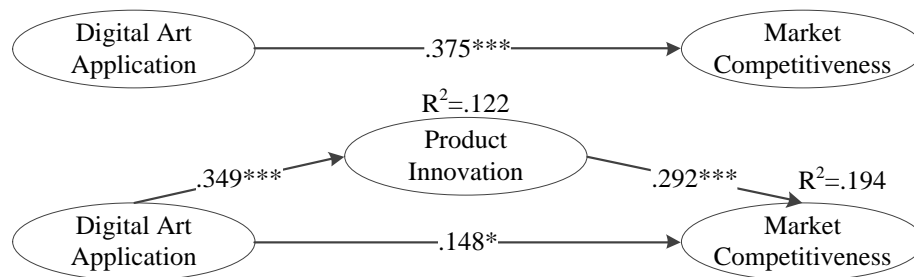
Variables	M	SD	DAA	PI	MC
DAA	3.773	0.937	1		
PI	3.561	0.802	0.478***	1	
MC	3.669	0.824	0.395***	0.446***	1

**Note:** DAA (Digital art application); PI (Product innovation); MC (Market Competitiveness); \*\*\* $p < 0.001$ .

#### 4.3. Structural Equation Modeling

This study employed the stepwise approach proposed by Baron and Kenny [39] to investigate potential mediation effects. The process involves four essential criteria: Criterion 1 requires the independent variable to have a significant impact on the dependent variable. Criterion 2 mandates that the independent variable significantly influences the mediator variable. Criterion 3 specifies that the mediator must significantly affect the dependent variable. Lastly, Criterion 4 indicates that when the mediator is included, the impact of the independent variable on the dependent variable should be reduced.

Following the stepwise approach of Baron and Kenny [39], as shown in Figure 2, this study first established a direct model (a), emphasizing the impact of the independent variable (digital art application) on the dependent variable (market competitiveness). Subsequently, an indirect model (b) was established, incorporating the mediator variable (product innovation). For model (a), the fit indices were recorded as:  $\chi^2/df = 2.861$ , RMSEA = .075, GFI = .914, AGFI = .880, SRMR = .044; whereas for model (b), the fit indices were:  $\chi^2/df = 4.699$ , RMSEA = .067, GFI = .902, AGFI = .854, SRMR = .046. These fit indices indicate that the models have a good fit with the empirical data.



**Figure 2.**

Results of structural model.

**Note:** (a) Direct path model; (b) Indirect path model; \* $p < .01$ ; \*\*\* $p < 0.001$ .

As shown in Table 3, the analysis of the direct path (a) model indicates that the application of digital art has a significant positive impact on market competitiveness ( $\beta = .375$ ,  $p < .001$ ,  $CI = [.015, .163]$ ), which supports Hypothesis H1.

In the indirect path (b) model, further analysis reveals how this impact is mediated through product innovation. The study found that the application of digital art has a significant positive effect on product innovation ( $\beta = .349$ ,  $p < .001$ ,  $CI = [.004, .130]$ ), and in turn, product innovation significantly positively influences market competitiveness ( $\beta = .292$ ,  $p < .001$ ,  $CI = [.017, .160]$ ). This series of significant effects not only supports Hypotheses H2 and H3 but also meets the criteria proposed by Baron and Kenny for verifying mediation effects, where the independent variable significantly influences the mediator variable, and the mediator variable significantly influences the dependent variable.

After introducing the mediator variable, product innovation, the effect coefficient of digital art application on market competitiveness decreased from 0.375 in the direct path (a) model to 0.148 in the indirect path (b) model. This change confirms Hypothesis H4, indicating that the direct effect of the independent variable on the dependent variable weakens after introducing the mediator variable, thereby confirming the existence of a mediation effect. This result aligns with the fourth criterion of Baron and Kenny's [39] stepwise approach, which states that the relationship between the independent variable and the dependent variable changes significantly due to the influence of the mediator variable.

**Table 3.**

Standardized regression coefficients.

Model	Path	$\beta$	S.E.	$t$	$p$	Results
Direct path model (a)	DAA→MC	0.375	0.053	5.125	***	H1 is support
Indirect path model (b)	DAA→PI	0.349	0.061	4.741	***	H2 is support
	PI→MC	0.292	0.054	4.102	***	H3 is support
	DAA→MC	0.148	0.060	2.758	0.037	-

**Note:** DAA (Digital art application); PI (Product innovation); MC (Market competitiveness); \*\*\* $p < 0.001$ .

## 5. Discussion

The application of digital art has a significant positive impact on the market competitiveness of the old industrial base in Northeast China, consistent with the findings of scholars such as Dai [21], Elia et al. [24], Li et al. [23], Li [2], Paul [4], Raja and Priya [22], and Wang et al. [25]. Digital art enhances the visual impact and user experience of cultural and creative products by enriching their forms of expression and artistic styles, thereby strengthening their market competitiveness. The introduction of digital technologies, such as virtual reality and augmented reality, provides new sources of creativity and technical support for cultural and creative products, helping them stand out in fierce market competition. This finding suggests that digital art is not only an important means of innovation in cultural and creative products but also a key factor in enhancing product market competitiveness.

The application of digital art significantly promotes product innovation in cultural and creative products in the old industrial base in Northeast China, similar to the conclusions of scholars such as Cohen [3], De Bernard et al. [28], Kamariotou et al. [9], Landoni et al. [27], O'Dwyer [6], Kraus et al. [5], and Tricarico et al. [26]. Digital art enriches the design language and functions of cultural and creative products through technological innovation and creative methods, facilitating product updates and development. Digital art makes cultural and creative products more diverse and personalized in design and function, better meeting the needs of modern consumers. Through digital technology, traditional crafts can be endowed with new visual effects and interactive functions, and cultural heritage can be virtually recreated, providing broad space and possibilities for the innovation of cultural and creative products.

Product innovation has a significant positive impact on the market competitiveness of the old industrial base in Northeast China, aligning with the conclusions of scholars such as Caliskan et al. [29], Chang et al. [30], Ghobakhloo et al. [13], Naeem and Di Maria [11], Prima Lita et al. [12], Purchase and Volery [10], and Yan et al. [7]. Product innovation continuously updates and improves the design, functionality, and performance of cultural and creative products, enabling them to better adapt to market demands and consumer expectations, thereby enhancing their market competitiveness. By introducing new materials, technologies, or design concepts, cultural and creative products achieve comprehensive upgrades in appearance, quality, and utility, gaining more recognition and popularity in the market. This indicates that product innovation is one of the key strategies for gaining an advantage in market competition within the cultural and creative industries.

Product innovation plays a mediating role between the application of digital art and market competitiveness. Digital art influences the market competitiveness of cultural and creative products by driving product innovation. The application of digital art not only enriches the artistic forms of cultural and creative products but also enhances their market adaptability and consumer recognition through technological innovation and functional design. The existence of this mediating effect further validates the importance of digital art in the innovation of cultural and creative products and indicates that product innovation is a critical pathway to realizing the value of digital art applications.

### *5.1. Theoretical Contributions*

This study empirically verifies the critical role of digital art in cultural and creative product innovation and market competitiveness, filling a gap in the existing literature in this field. The findings not only reveal the positive impact of digital art application on product innovation but also confirm the mediating role of product innovation between digital art application and market competitiveness. These findings offer a fresh theoretical perspective and practical guidance for the digital transformation of the cultural and creative industries, extending the application of the Diffusion of Innovations theory within the domain of cultural and creative products.

### *5.2. Practical Contributions*

This study provides valuable practical insights for both practitioners and policymakers within the cultural and creative industries. By highlighting the key role of digital art in enhancing product innovation and market competitiveness, the findings provide specific operational pathways for cultural and creative enterprises in the development and promotion of digital art applications. Additionally, the study emphasizes the importance of product innovation as a mediator, suggesting that companies should focus on innovation in product functionality and design when applying digital art to enhance market competitiveness. These practical contributions will help drive the continuous development and digital transformation of the cultural and creative industries.

### *5.3. Research Limitations*

Despite revealing the significant role of digital art in cultural and creative product innovation, this study has some limitations. First, the research was conducted using samples from the old industrial base



in Northeast China, which may limit the generalizability of the results due to regional constraints. Second, the data collection relied on convenience sampling, which may affect the representativeness of the sample. Moreover, the research methodology primarily depended on questionnaire surveys, where subjective evaluations by respondents might lead to data biases. Future research could broaden the sample size and utilize diverse data collection methods to improve the generalizability and reliability of the findings.

## 6. Discussion

Through an empirical analysis of the old industrial base in Northeast China, this study explored the role of digital art in cultural and creative product innovation and market competitiveness. The results indicate that the application of digital art significantly enhances the visual impact and user experience of cultural and creative products, thereby strengthening their market competitiveness. At the same time, digital art drives product innovation, making cultural and creative products more diverse and personalized in design and functionality, which meets the needs of modern consumers. Product innovation was confirmed as an important mediator between digital art application and market competitiveness. Although the study has limitations related to regional focus and data collection methods, the findings provide valuable theoretical and practical guidance for the development of the cultural and creative industries. In the future, as technology advances and market demands evolve, digital art is expected to play an increasingly important role in cultural and creative products, injecting new vitality into industry development. It is recommended that companies and policymakers focus on the application of digital art and product innovation to enhance the market competitiveness and innovation capacity of cultural and creative products.

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