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Article

Research on the Relationship between Digital Marketing Strategies for the Ceramic Cultural Industry and Business Operational Efficiency

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Abstract: As a cultural industry rooted in the Chinese nation's long history and unique artistic heritage, the ceramic cultural industry faces both significant challenges and immense market opportunities in the context of the global digital economy. This paper conducts an empirical analysis using three models—DEA, MPPI, and the Tobit model—to investigate the transmission mechanisms through which different intensities of digital marketing influence corporate operational efficiency, based on operational efficiency data from ceramic cultural industry enterprises. Empirical research findings indicate that a one-unit change in digital marketing intensity results in an average change of 0.287 units in operational efficiency. Among these, the regression parameter for technological innovation reaches 0.423, indicating that R&D investment intensity has an excellent promotional effect on operational efficiency. This study concludes that the ceramic cultural industry should actively address the market challenges and opportunities brought by the digital economy, continuously enhance the level of technological innovation investment, and adopt diversified digital marketing strategies based on the industry characteristics of their own enterprises and external market conditions. By learning and applying digital marketing through continuous imitation, enterprises can improve the effectiveness of digital marketing, thereby promoting and optimizing operational efficiency and sustainable development levels.

Keywords: ceramic cultural industry; digital marketing strategies; enterprise operational efficiency; technological innovation

1. Introduction

In recent years, the digital economy has emerged as a key driver of economic growth and a catalyst for industrial transformation and development. Concurrently, innovations in digital marketing have further stimulated industrial innovation and vitality [1]. As the "Thousand-Year Ceramic Capital," Jingdezhen boasts a rich heritage and abundant resources in ceramic culture [2]. In July 2019, the Chinese government officially approved the construction of the Jingdezhen National Ceramic Cultural Heritage and Innovation Pilot Zone, bringing new opportunities and challenges to the ceramic cultural industry in Jingdezhen [3-5]. In this context, digital marketing strategies have also had a significant impact on the development of the ceramic industry. Essentially, marketing strategies can to some extent reflect the economic benefits and development trends of an industry [6]. With the rapid development of the internet, "online + offline" sales have become a new marketing model for the ceramic cultural industry. In particular, the rise of live-streaming e-commerce in recent years has directly driven the rapid development of online sales channels for the ceramic cultural industry [7-9]. Under the backdrop of the digital economy, the ceramic industry's market scale continues to expand, development models

are constantly innovating, and ceramic business formats are becoming increasingly diversified, with overall development trends remaining positive [10]. However, under the strong attraction of a vast market and huge profits, the number of small and medium-sized ceramic enterprises has surged, and the number of ceramic industry workers has also risen sharply, with the drawbacks of this development becoming increasingly evident [11-12]. To stand out in the market, enterprises need to formulate a series of marketing strategies to address these challenges.

Scholars have primarily focused their research on the impact of digital marketing strategies on business performance. For example, Wu, C., et al. examined the relationship between digital marketing strategies and the operational performance of small and medium-sized enterprises from three aspects: innovation, proactivity, and management capabilities. They concluded that such strategies significantly and positively promote the operational performance of small and medium-sized enterprises [13]. Regarding the formulation of digital marketing strategies, Schallmo, D., et al. proposed a digital marketing strategy development model based on expert opinions and case studies, which includes six stages (external strategic analysis, strategic forecasting, internal strategic analysis, strategic principles, strategic selection, and strategic formulation) and four general strategies [14]. Zhang, L., et al. used companies listed on the Growth Enterprise Market from 2019 to 2023 as their research sample. Starting from the impact of digital marketing on corporate performance, their empirical test results proved that digital transformation and performance growth strategies in this strategy can greatly promote corporate performance, and they proposed improvement suggestions for digital transformation and innovation [15]. Hadiyati, E., et al. explored the complex relationships between digital marketing, customer relationship management, corporate competitiveness, and business performance in SMEs. The study found that effective digital marketing strategies can enhance business performance, with customer relationship management and corporate competitiveness playing a mediating role [16]. Soekiman, S. examined the impact of strategic human resource management (SHRM) on business performance in the context of digital marketing. The study found that SHRM has a positive impact on business performance, and this impact is further enhanced by digital marketing capabilities [17]. From the above studies, it can be seen that there is a direct or indirect relationship between digital marketing strategies and business performance to a certain extent.

Few scholars have studied the impact of digital marketing strategies on business operational efficiency. For example, Krisnanto, A., et al. studied the impact of entrepreneurial orientation, digital marketing, and marketing capabilities on corporate operational efficiency, finding that these factors exert direct or indirect influences on operational efficiency [18]. Research on corporate operational efficiency has primarily focused on the impact of digital transformation on operational efficiency. For instance, Wujarso, R., examined the impact of digital transformation on operational efficiency in his study, with results indicating that digital transformation significantly enhances operational efficiency and improves overall corporate performance [19]. Yu, J., et al. conducted an empirical study using digital transformation capability as an indicator to measure the impact of strategic orientation on operational efficiency. The results showed that strategic orientation has a significant positive impact on digital transformation capability, and digital transformation capability can enhance operational efficiency and achieve sustainable competitive advantages [20]. AbRahim, H., et al. conducted an empirical study on the application of digital marketing in the business field, using a neural network model to determine the impact of key factors such as proactivity, risk-taking, resource utilization, opportunity focus, strength, and value creation on operational efficiency, with the aim of providing relevant reference opinions for SMEs [21]. The above studies primarily focus on the relationship between digital transformation and operational efficiency, while research on the impact of digital marketing strategies on operational efficiency remains scarce.

Based on an analysis of the influence relationship between digital marketing strategies and operational performance in the ceramic cultural industry, this paper adopts a mixed-method research approach. In the process of establishing hypotheses and conducting validation under theoretical premises, the qualitative and quantitative relationships are explored through data analysis strategies following a theoretical construction—empirical testing—empirical interpretation framework. The Malmquist productivity index is employed to study the persistent effects of digital marketing strategies on operational performance. A panel data model is established to control for individual firm heterogeneity and time-varying effects. Sensitivity analysis of research methods and tools is conducted, including replacing key measurement variables, adjusting the scope of variable selection, and adopting different model settings, to ensure the reliability of research conclusions.

2. Research on the Impact of Digital Marketing Strategies on Business Operational Efficiency

This study investigates the relationship between digital marketing strategies and operational performance in the ceramic cultural industry. The proposed mixed-method research design framework follows the general research pathway of theoretical construction—empirical validation—mechanism derivation: First, a literature review method will be employed to systematically review literature published in databases such as Web of Science, CNKI, and Wanfang Data, focusing on topics related to digital marketing, operational performance, the cultural industry, and the ceramic industry. Relevant literature will be identified and screened within the timeframe of 2010–2023, systematically identifying areas of hot research and theoretical gaps, which will serve as the theoretical foundation and research framework for this study. The case study analysis method focuses on enterprises in major Chinese ceramic production areas such as Jingdezhen, Dehua, and Yixing. Case selection follows the principle of theoretical sampling, considering factors such as the ceramic production area where the case enterprises are located, the type of ceramic products, market positioning, the extent of digital marketing application, and innovative practices. Detailed enterprise information is obtained through methods such as interviews, questionnaires, and on-site visits. First, typical facts from representative enterprises are summarized and refined, and comparative analysis is used to identify the distinctive patterns among different types of enterprises. Second, based on industrial practices, basic information about cultural industry enterprises in major ceramic production areas, the status of digital marketing implementation, enterprise operational performance, factors influencing the implementation of digital marketing strategies in the ceramic cultural industry, and enterprise operational performance are collected to create a questionnaire survey form. The questionnaire primarily consists of four sections: first, enterprise basic information; second, the current status of digital marketing strategy implementation; third, enterprise operational performance evaluation indicators. Fourth, key factors influencing the operational performance of digital marketing in the ceramic cultural industry. Through a questionnaire survey of 300 ceramic cultural industry enterprises, 300 valid questionnaires were obtained. Through in-depth interviews with enterprise operators, marketing professionals, industry association leaders, and other relevant stakeholders, using semi-structured interviews lasting approximately 60–90 minutes, the interview data was categorized and analyzed using thematic coding.

2.1. Association Model Design

Based on the data envelope analysis method, which is one of the methods for measuring a company's technical efficiency, this analysis method does not require the prior selection of a production function formula and can be applied to problems involving multiple inputs and multiple outputs. The basic formula for calculating technical efficiency is as follows:

$$TE=\frac{\text{Total output}}{\text{Total investment}} \tag{1}$$

Output is composed of a combination of indicators such as operating revenue, brand value, and cultural influence, while input consists of human resource costs, material costs, marketing costs, and R&D investment. The DEA model is used to select leading companies on the efficiency frontier, and the distance of each company from the efficiency frontier is measured to obtain an objective evaluation of the company's efficiency. The Marquis productivity index is used to analyze the dynamic changes in enterprise operations. The Marquis index is a decomposition index of productivity changes, consisting of changes in technical efficiency and technological progress. The calculation formula for the Marquis index is:

$$\text{Malmquist index}=\frac{TE_{t+1}}{TE_t} \tag{2}$$

Among these, TE_{t+1} and TE_t represent the technical efficiency values for periods (t+1) and t, respectively. An index greater than 1 indicates an increase in efficiency, while an index less than 1 indicates a decrease in efficiency. Through continuous panel data analysis over multiple years, the long-term evolution of corporate operational efficiency is identified, and the sustained impact of digital marketing strategy implementation is evaluated. The Tobit regression model is used to analyze the mechanism through which digital marketing strategies influence corporate operational efficiency. This model can handle cases where the dependent variable exhibits truncation characteristics and is suitable

for analyzing constrained dependent variables with efficiency values between 0 and 1. The basic form of the regression model is:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \varepsilon \tag{3}$$

In this model, Y represents corporate operational efficiency, X_1 and X_2 represent the strength of digital marketing strategies and control variables, respectively, β_0 is the constant term, β_1 and β_2 are the regression coefficients, and ε is the random error term. By estimating the magnitude and significance of the regression coefficients, the study quantifies the extent of the impact of digital marketing strategies on operational efficiency, identifies key influencing factors, and tests the research hypotheses. The model incorporates control variables such as firm size, years in operation, ownership structure, and geographical location, as well as interaction terms between digital marketing strategies and firm characteristics, to comprehensively analyze the complexity of the influencing mechanisms. To ensure the robustness of the research results, multiple econometric methods are employed for sensitivity analysis, including changing the measurement methods for key variables, adjusting the sample range, and using different model specifications, to validate the research conclusions from multiple angles and ensure their scientific validity.

2.2. Data Collection and Processing

This study employs multiple data collection methods to obtain relevant information on digital marketing and operational efficiency in the ceramic cultural industry. Questionnaire surveys serve as the primary data source, covering core ceramic production areas such as Jingdezhen in Jiangxi Province, Dehua in Fujian Province, Yixing in Jiangsu Province, Foshan in Guangdong Province, and Zibo in Shandong Province. The questionnaire design includes four modules: basic company information, implementation status of digital marketing strategies, operational efficiency-related indicators, and identification of influencing factors, comprising a total of 68 measurement items. Basic company information includes structural variables such as years in operation, number of employees, annual revenue, and main product types. The digital marketing strategy module investigates the implementation of social media marketing, search engine marketing, content marketing, live-streaming e-commerce, and short video promotion. The operational efficiency module designs measurement indicators from dimensions such as financial performance, market performance, brand influence, and innovation capability.

The questionnaire uses a five-point Likert scale, with reverse-scored questions and consistency checks to enhance data quality. A stratified sampling method was used to ensure sample representativeness, with companies categorized into three tiers based on size: large enterprises (annual revenue exceeding 50 million yuan), medium-sized enterprises (annual revenue between 10 million and 50 million yuan), and small enterprises (annual revenue below 10 million yuan). The sample ratios for each tier were 3:4:3, resulting in 278 valid questionnaires with an effective response rate of 92.67%.

In-depth interviews were conducted in a semi-structured format, with participants including senior management, marketing department heads, digital marketing specialists, and industry experts. The interview outline focused on core topics such as the digital marketing strategy formulation process, implementation effectiveness evaluation, challenges encountered, and perceptions of the impact on operational efficiency. Each interview lasted 60–90 minutes and was recorded to ensure information integrity. A total of 42 in-depth interviews were completed, including 18 senior executives, 15 marketing managers, 6 technical personnel, and 3 industry experts.

The interview content was converted into written materials using professional transcription software and analyzed using NVivo qualitative analysis software to identify key themes and concepts, providing theoretical support and an explanatory framework for quantitative analysis. The collection of annual report data focused on publicly available financial information from listed ceramic companies. Panel data for the five consecutive years from 2019 to 2023 was obtained through authoritative channels such as the Giant Tide Information Network, the Shanghai Stock Exchange official website, and the Shenzhen Stock Exchange official website. The names and operational data of the 10 companies are detailed in Table 1. The collected indicators include financial data such as operating revenue, operating costs, management expenses, R&D expenses, fixed assets, number of employees, and net profit, as well as innovative indicators such as digital marketing investment, brand value assessment, and patent application numbers, forming a panel dataset comprising 125 observations from 10 listed ceramic companies.

Table 1. Enterprise Name and Operation Data (Unit: 10,000\)

Enterprise Name	Operating income	Operating costs	Administrative expenses	Fixed assets	Investment in digital marketing
Jingdezhen Ceramics Co., LTD	45680	32476	3254	28965	1823
The culture of Dehua, the Porcelain capital	23450	16815	1876	15632	938
Yixing purple clay art	18920	13244	1523	12087	756
Foshan Ceramics Group	67890	48523	4567	42156	2712
Zibo ceramics	31240	22368	2487	19876	1248
Tangshan Bone China industry	28760	20132	2156	17543	1147
Liling underglaze painting	15680	10976	1234	9876	627
Longquan Celadon Workshop	12340	8638	987	7654	493
Jianshui Zitao Xuan	9870	6909	765	5432	394
Jun Porcelain Culture Company	21560	15092	1678	13245	862

The data preprocessing stage strictly follows standardized procedures for detecting and handling missing values. For variables with a missing rate below 5%, mean imputation is used. Observations with a missing rate exceeding 10% are deleted, leaving 278 valid samples. Outlier identification combines box plot analysis and standard deviation methods. Extreme values exceeding the range of the mean ± 3 standard deviations are subjected to Winsorization, where the 1st percentile and 99th percentile values replace the extreme values to ensure the rationality of the data distribution. Data standardization employs the Z-score standardization method to eliminate the impact of differing measurement scales across variables on analysis results. The standardization formula is:

$$Z = \frac{X - \mu}{\sigma} \tag{4}$$

Among them, X is the original value, μ is the mean, and σ is the standard deviation.

During the variable construction process, the strength of digital marketing strategies was synthesized into a single indicator through principal component analysis, operational efficiency was calculated using the data envelopment analysis model, and the effectiveness of cultural value dissemination was determined by weighting and summing the results using the analytic hierarchy process. Data quality control measures include reliability and validity tests. The internal consistency of questionnaire data is evaluated using Cronbach's Alpha coefficient, with all dimension α coefficients exceeding 0.8, indicating that the measurement tools have good reliability. Validity testing was conducted using exploratory factor analysis and confirmatory factor analysis. The KMO value was 0.876, the Bartlett sphericity test significance level was less than 0.001, factor loadings were all greater than 0.6, and the cumulative variance explained reached 73.4%, proving that the questionnaire has good structural validity.

In terms of data analysis software selection, SPSS26.0 was used for descriptive statistical analysis, DEAP2.1 software was used for data envelopment analysis efficiency calculation, MaxDEA software was used for Marquist index calculation, and Stata 16.0 was used for Tobit regression analysis. In order to ensure the robustness of the analysis results, a variety of measurement methods were used for sensitivity analysis of key variables, and the intensity of digital marketing strategy was measured by different indicators such as the proportion of investment amount, activity frequency, and number of platforms, and the operational efficiency was compared and verified by using the ratio analysis method in addition to the data envelopment analysis method. A standardized database management system has been established for data collation, and a relational database structure is used to store data from different sources to ensure data integrity and consistency. The data coding adopts a unified naming convention, and the enterprise code, time variables, and indicator variables are all encoded according to the preset standards, which is convenient for subsequent analysis and traceability. Explain what each variable means, how it is constructed, where the data comes from, how it is processed, etc., to improve the reproducibility of the study. Archive data repositories. It ensures the storage of raw data and the results of data processing, and adopts a multi-archive data strategy to prevent data loss. The analysis dataset includes 278 enterprise samples, five-year data from 2019 to 2023, and a total of 45 variable data, which provides sufficient data resources for empirical analysis. Data description statistics show that the average operating income of the sample enterprises is 287 million yuan, the standard deviation is 194 million yuan, the average value of digital marketing in operating income is 3.8%, and the average operating efficiency is 0.742.

2.3. Building a model linking digital marketing strategies and operational efficiency

This paper employs Data Envelopment Analysis (DEA), the Marquis Productivity Analysis (MPA) method, and the Tobit model to establish a three-tiered empirical analysis framework. It conducts an empirical analysis of management efficiency in ceramic cultural and creative enterprises and empirically tests the impact of online marketing.

DEA is a non-parametric efficiency analysis method for handling multiple inputs and outputs. It does not require the prior determination of the specific equation form of a production function and can effectively address the issues of multiple outputs and inputs faced by the complex production patterns of the ceramic cultural industry. This paper adopts the BCC model, which is a variable returns to scale model centered on outputs, to decompose technical efficiency into technical efficiency and scale efficiency, thereby identifying the more specific causes of efficiency losses. The Malmquist productivity index is primarily used to analyze the patterns of changes in enterprise production efficiency over time. The index divides changes in total factor productivity into two components: changes in technical efficiency and technological progress, enabling the identification of the sources of efficiency changes. This study uses DEA to calculate the Malmquist index and constructs efficiency frontier surfaces for different periods based on DEA's efficiency value calculation method to analyze changes in enterprise positions.

The model design takes into account the special characteristics of the ceramic cultural industry. The input-output indicators selected include both traditional economic indicators and intangible output indicators such as cultural value and brand value. The variable definitions and measurements are shown in Table 2. Principal component analysis is used to combine multi-dimensional indicators such as social media marketing, content marketing, live streaming marketing, and search engines into a single indicator of marketing digitalization intensity. Using multiple indicators to form a single indicator in this way avoids multicollinearity issues. The control variables in this study are based on industry attributes and existing literature results, primarily including firm size, firm age, firm technological capability, and market concentration, to ensure the robustness of the regression results. The model estimation method employs maximum likelihood estimation, using an iterative method to estimate the optimal parameter values.

Table 2. Model Variable Definitions and Measurement Methods

Variable type	Variable name	Variable definition	Measurement method
DEA input variable	Labor cost	The total annual employee compensation of the enterprise	Financial statement data
	Material cost	Raw materials and production costs	Operating costs minus labor costs
	Marketing expenses	Total investment in digital marketing	Details of marketing expenses
	Fixed assets	The value of production equipment and factory buildings	Net value of fixed assets
DEA output variable	Operating income	Annual total revenue of the enterprise	Financial statement data
	Brand value	Brand influence assessment	Brand Value assessment report
	Cultural dissemination	Cultural influence index	Comprehensive score of media exposure and social influence
	The intensity of digital marketing	The degree of implementation of digital marketing strategies	Comprehensive score of principal component analysis
Tobit explanatory variable	Enterprise scale	Annual operating income of the enterprise	The logarithm of operating income
	Enterprise age	Years of establishment of the enterprise	The current year minus the year of establishment
	Technological innovation	Intensity of R&D investment	R&D costs account for the proportion of operating income
	Market concentration	Degree of industry competition	Herfindahl Index

To ensure the robustness of the estimation results, this study employed multiple testing methods to validate the model's validity, with the specific analytical framework shown in Figure 1:

First, a model specification test was conducted using the Hausman test to determine whether the Tobit model should be used instead of the ordinary linear regression model.

Second, a heteroskedasticity test was conducted using the White test to identify whether the residual terms exhibited heteroskedasticity. If so, robust standard errors were used for correction.

Third, a multicollinearity test was conducted by calculating the variance inflation factor (VIF) to ensure that there was no severe multicollinearity among the explanatory variables.

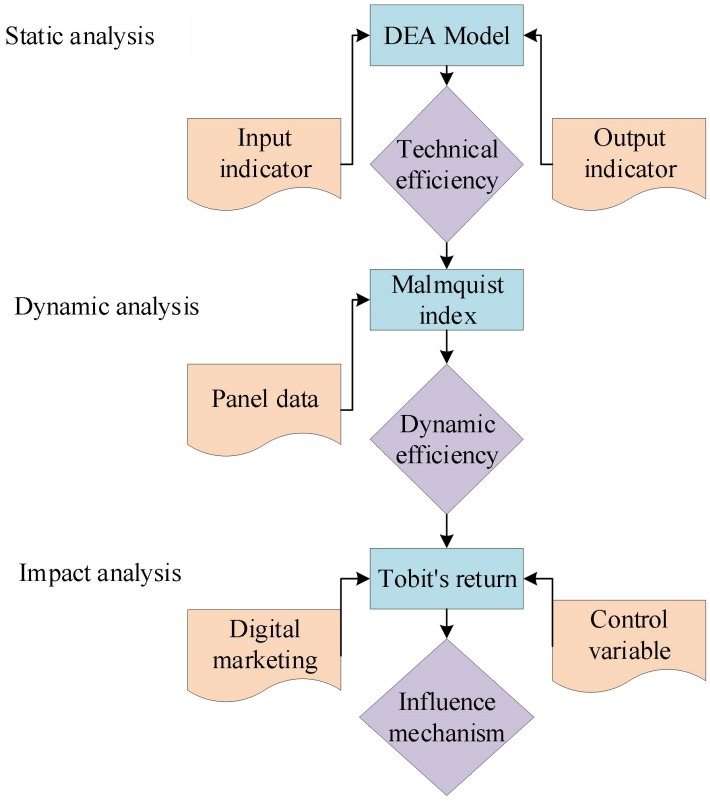

Figure 1. Three-stage Model Analysis Framework

In terms of the marginal effect analysis method for the model, the average marginal effect is employed to determine the extent to which different explanatory variables influence the dependent variable, providing a quantitative basis for subsequent policy recommendations. By constructing these three interconnected analytical models, this paper can grasp the intrinsic connections between the digital marketing strategy and operational efficiency of the ceramic cultural industry from three levels: static efficiency evaluation, dynamic characteristics, and the extraction of influencing factors. This lays a foundational empirical analytical method for the subsequent empirical analysis.

3. Analysis of empirical results

3.1. Data Analysis and Results

3.1.1. DEA Data Results

The DEA data results are shown in Table 3. The results indicate that the comprehensive technical efficiency level of the sample enterprises is 0.742, meaning that under the current input conditions, the resource allocation and production management of the ceramic cultural industry can still be optimized by 25.8%. From the efficiency distribution perspective, 48 companies have reached the efficiency frontier value (efficiency value of 1.0), accounting for 17.3% of the total number of sample companies. These high-efficiency companies are primarily located in Jingdezhen, Dehua, and other regions with a long history and extensive experience in ceramic production. They have effectively leveraged their deep cultural heritage and mature marketing strategies to gain a competitive advantage. There are 89 companies with efficiency values between 0.8 and 0.9, accounting for 32.0% of the sample companies. These companies have established a certain level of brand recognition and technical foundation but still

need to improve in the application of digital marketing tools and overall marketing strategies. There are 67 companies with efficiency values below 0.6, accounting for 24.1% of the sample companies. These companies are primarily small and medium-sized artisanal workshops, and they generally face issues such as outdated technology, traditional marketing methods, and a lack of brand cultivation awareness.

Table 3. DEA Data Analysis Results

Analytical method	Indicator name	Mean	SD	Minimum value	Maximum value
Maximum value	Integrated technical efficiency	0.742	0.186	0.312	1.000
	Pure technical efficiency	0.823	0.154	0.445	1.000
	Scale efficiency	0.901	0.098	0.623	1.000
Malmquist index	Total factor productivity	1.087	0.234	0.678	1.456
	Changes in technical efficiency	1.023	0.187	0.734	1.298
	Technological progress	1.198	0.156	0.812	1.387
Tobit's return	The intensity of digital marketing	0.634	0.298	0.156	0.987
	Enterprise scale	8.456	1.234	6.123	11.234
	Technological innovation	0.045	0.023	0.008	0.134
	Market concentration	0.234	0.087	0.098	0.456

The average pure technical efficiency of 0.823 is higher than the comprehensive technical efficiency, indicating that the efficiency losses of ceramic cultural industry enterprises primarily stem from the loss of scale efficiency rather than efficiency losses caused by technical level management. The average scale efficiency of 0.901 suggests that most enterprises are operating at an optimal production scale, but there is still room for improvement. When comparing the efficiency of enterprises of different scales, we can see that enterprises with annual revenues of 10 million to 50 million yuan have the highest average efficiency, at 0.798. These enterprises have sufficient resource strength to meet resource demands and also possess strong operational flexibility to adapt to market changes and updates in products and technology.

3.1.2. Productivity Index Results

Through the analysis of the Marquis Productivity Index, it can be seen that the Marquis Index examines the dynamic trajectory of operational efficiency in the ceramic cultural industry from 2019 to 2023. The Marquis Productivity Index calculated as shown in Table 4 indicates that the overall total factor productivity of the sample enterprises exhibits incomplete dynamic productivity growth. In 2019, due to the impact of the pandemic, the average Marquis index value was 0.934. The sample enterprises primarily relied on traditional channels for sales. Factors such as pandemic control measures, internal and external reasons leading to inability to ship goods and raw material shortages, as well as reduced consumer demand due to overall economic pressure, all contributed to a decline in industry production efficiency. In 2020, under the normalized pandemic prevention and control measures, the Marquisette Index rose to 1.087 with the development of digital network e-commerce. This indicates that the sample companies accelerated the adjustment of their external sales strategies in response to pandemic requirements, experimented with digital marketing, transformed their marketing concepts, expanded online sales channels, and explored new design elements, effectively addressing operational challenges. In 2021, the Marquis Index rose to 1.142, indicating that with the development of digital network-based e-commerce, the sample companies achieved new breakthroughs in brand building, customer relationship maintenance, and market promotion, gradually demonstrating their marketing advantages. In 2022, the Marquis Index reached 1.186, the highest value in five years, indicating that the digital transformation of the ceramic cultural industry has achieved initial success.

Table 4. Malmquist index analysis results

Indicator name	Malmquist index			The Malmquist index average
	Total factor productivity	Changes in technical efficiency	Technological progress	
2019	0.912	0.837	1.054	0.934
2020	1.054	0.894	1.314	1.087
2021	1.058	1.021	1.204	1.142
2022	1.115	1.149	1.295	1.186
2023	1.300	1.212	1.124	1.212
Mean	1.087	1.023	1.198	—

After decomposing the Marquis index into three components—total factor productivity, changes in technical efficiency, and technological progress—it was found that technological progress has become the primary driver of total factor productivity growth. The average technological progress index was 1.198, and the technical efficiency index change was 1.023. This indicates that technological progress factors such as the widespread application of digital technology, continuous improvements in production processes, and updates and upgrades in product design concepts have made significant contributions to improving the operational efficiency of the ceramic cultural industry.

3.1.3. Analysis of regression results

The Tobit regression model analysis indicates that there is a significant positive correlation between digital marketing activities and the operational efficiency of ceramic cultural industry enterprises. In the regression, the regression coefficient for the intensity of digital marketing activities is 0.287, with a positive significance value at the 1% significance level. This suggests that for every 1-point increase in the intensity of digital marketing activities, the average operational efficiency of enterprises increases by 0.287 points. This clearly demonstrates that digital marketing activities contribute to enhancing the operational efficiency of ceramic cultural industry enterprises. The regression coefficient for the enterprise scale variable is 0.156, with a positive significance value at the 5% significance level. This indicates that larger-scale enterprises are more likely to have higher operational efficiency, which may be closely related to the comprehensive advantages that large enterprises possess in terms of resource integration capabilities, technology, and market development.

The regression coefficient for the technological innovation variable is 0.423, and it is significantly positive at the 1% significance level, indicating that R&D investment intensity has a significant promotional effect on operational efficiency. For every 1 percentage point increase in R&D investment, the average operational efficiency of enterprises improves by 0.423 units. The regression coefficient for the market concentration variable is -0.198, which is significantly negative at the 10% significance level. This suggests that intensified market competition may have a negative impact on operational efficiency, potentially due to factors such as price wars and rising marketing costs triggered by intense competition. The regression coefficient for the firm age variable is 0.089, but its statistical significance is relatively weak, indicating that the firm's age has a limited impact on operational efficiency. The overall model fit is good, with a pseudo R^2 value of 0.342, indicating that the model can explain 34.2% of the variation in the dependent variable, demonstrating strong explanatory power.

3.2. Sensitivity Analysis and Robustness Testing

To examine the robustness of the above results, further robustness analysis was conducted. By changing the metric for measuring the intensity of digital marketing strategies (replacing the digital marketing strength component score with the ratio of digital marketing expenses to total expenses), the estimated results remained positive and significant, with a magnitude of 0.243, which is largely consistent with the conclusions of the baseline regression in this paper.

When using quantile regression to study the impact of efficiency heterogeneity among firms at different quantiles, the results showed a significant promotional effect of digital marketing strategies on low-efficiency firms. The regression coefficient at the 25th quantile was 0.356, while the coefficient at the 75th quantile was 0.198, indicating that digital marketing strategies can effectively support lagging firms in narrowing the efficiency gap with leading firms.

The results from the instrumental variables method also reaffirm the causal relationship between digital marketing initiatives and operational efficiency. Using regional internet usage rates as an instrumental variable for digital marketing intensity, the estimated coefficient from the two-stage least squares method is 0.312, which is extremely similar to the benchmark estimation results.

In the subgroup regression analysis, we can observe different influence patterns across different types of enterprises. The regression coefficient for digital marketing strategies on traditional craft enterprises is 0.234, while the coefficient for innovative design-oriented enterprises reaches 0.341, indicating that digital marketing strategies have a greater promotional effect on the efficiency of innovative enterprises.

Regional differences show that digital marketing performance in eastern coastal regions is superior to that in central and western regions, which is closely related to the local level of digital infrastructure development, consumer acceptance of digital technologies, and human resource conditions.

Based on the above discussion, the author reaches the following basic conclusion: digital marketing has a significant positive impact on the performance of ceramic cultural enterprises, and this conclusion remains stable across controlled variables and model forms, with high credibility. This

provides strong empirical evidence for the formulation and implementation of related policies and systems in the future.

3.3. Discussion and Analysis of Results

Based on the aforementioned empirical analysis, this paper further examines the mediating mechanism between digital marketing tools and the operational efficiency of the ceramic cultural industry. The results indicate that the positive impact of digital marketing tools on operational performance is primarily achieved through improving resource allocation efficiency, enhancing marketing responsiveness, and creating new models of cultural value. The Tobit regression analysis indicates that, holding other factors constant, a one-unit increase in the degree of digital marketing tools leads to a 0.287-unit improvement in corporate operational performance. This is because one of the core functions of digital marketing platforms is to leverage data to enhance operational efficiency.

Previous marketing efforts in the ceramic cultural industry relied more on experience-based decision-making and broad-based investments, resulting in significant information asymmetry and waste of marketing resources. Digital marketing solutions utilize big data technology to conduct real-time data analysis on marketing-related matters, achieve precise audience matching, and optimize the allocation of marketing investment structures, thereby enabling more efficient allocation of a company's marketing resources. Social media marketing uses user information analysis to predict the cultural preferences and consumption behavior of a company's target audience; content marketing uses content dissemination data analysis to adjust a company's cultural content production direction and marketing strategies; live-streaming e-commerce adjusts product display and sales strategies based on real-time customer interaction data during live streams. The comprehensive use of digital tools can effectively reduce marketing costs for ceramic cultural industry companies, thereby achieving more substantial market returns.

The Marquis Index also supports this conclusion, with an average technological progress index of 1.094, indicating that the penetration of digital technology is the core driver of improving total factor productivity in the ceramic cultural industry. Enhanced market responsiveness is an important mechanism through which digital marketing strategies improve operational efficiency. The ceramic cultural industry is a cultural and creative industry characterized by personalized, differentiated, and dynamic market features. Traditional marketing models inherently struggle to capture and respond to the dynamic changes in market demand. Digital marketing strategies provide enterprises with more flexible and rapid market response mechanisms through diverse digital touchpoints. By comprehensively applying digital marketing strategies, the average operational efficiency of enterprises reaches 0.912, exceeding that of non-adopting enterprises (0.642) by 0.170.

Technological investment and innovation serve as important intermediate variables in the relationship between digital marketing strategies and implementation efficiency. This aligns with previous literature emphasizing the significant influence of technological innovation on business operational efficiency. In regression analysis, the regression coefficient for the technological investment variable is 0.423, with a significant positive correlation at the 1% significance level, indicating that the intensity of R&D investment has a significant impact on improving business operational efficiency. The implementation of digital marketing strategies also requires certain technological support, such as investments in data analysis technology, content creation technology, and platform management technology. These investments influence the technological spillover process of businesses by enhancing their level of informatization and sharing technology, thereby strengthening their overall operational efficiency.

The heterogeneity of enterprise scale in the effects of digital marketing strategies further demonstrates the diverse transformation paths of enterprises of different scales in digitalization. Among them, medium-sized enterprises with a scale of 10 million to 50 million yuan have a significant effect in the implementation of digital marketing strategies, with an average operational efficiency of 0.798, exceeding the operational efficiency of large enterprises and micro and small enterprises. On one hand, this difference stems from medium-sized enterprises possessing both the basic resource capabilities to implement digital marketing strategies and the characteristics of streamlined organizational structures and swift decision-making processes, enabling them to more easily capture strategic innovations in digital marketing transformations within a dynamically changing digital marketing environment. On the other hand, it arises from differences in resource acquisition capabilities and organizational governance structures between medium-sized enterprises and large or small and micro-sized enterprises, leading to varying levels of sensitivity in dynamically changing digital marketing environments. The author believes that this study further confirms the effective positive impact of digital marketing on the commercial performance of ceramic cultural enterprises, while also examining its path mechanisms and influencing conditions. Based on this, it refines the

application of digital marketing research theory in traditional culture and provides theoretical support for the digital development of ceramic cultural enterprises.

4. Conclusion

On the one hand, this study theoretically expands the scope of research on digital marketing strategies in the traditional cultural industry sector, verifies the underlying mechanisms through which digital marketing strategies influence corporate operational efficiency, and provides scientific theoretical research and practical guidance for the formulation of digital transformation strategies for ceramic cultural industry enterprises. The findings of this study confirm that ceramic cultural industry enterprises should actively explore digital transformation, increase investment in and innovate digital marketing strategies, and establish targeted digital marketing implementation pathways based on their own scale and external environmental factors. Through continuous, incremental learning and improvement, they can enhance the effectiveness of digital marketing strategies, ultimately achieving improved operational efficiency and sustainable development.

On the other hand, while this study has made exploratory discoveries regarding the association between digital marketing strategies in the ceramic cultural industry and enterprise operational efficiency, it still has some limitations due to objective constraints such as research conditions and data acquisition restrictions. Future research should further examine the applicability and corrective effects of digital marketing strategies, focusing on developing distinct digital marketing strategy frameworks tailored to different cultural contexts. This should include studying how consumers perceive, evaluate, and purchase ceramic cultural products across various cultural backgrounds. The research should also prioritize the promotional effects of digital marketing strategies on cultural exchange, exploring how such strategies can better disseminate the intrinsic value of ceramic culture and enhance China's ceramic cultural influence on the global stage.

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