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Article

Debt Risk Analysis of Automotive Enterprises

Sovanhangmeas Chap * and Junyan Liu

School of Economics and Management, Qingdao University of Science and Technology, Qingdao 266000, China

Abstract: In order to maintain their financial stability, businesses must recognize and manage the financial risks that are necessarily involved in their operations and output. Businesses may better comprehend their financial status and undertake efficient risk early warning by examining financial indicators. Academic research on the detection and mitigation of financial risks is extensive, and in an effort to increase the accuracy of assessments, an increasing number of academics are using multi-indicator systems for thorough analysis. Furthermore, non-statistical techniques including hierarchical analysis, B-S option pricing models, and artificial neural networks have shown extremely effective at handling complicated data and non-linear connections. As the economy transitions from high to medium-high growth, traditional and new energy vehicles in the automobile sector confront significant possibilities and problems. Traditional automakers aggressively converting to new energy cars include SAIC Motor, BAIC Group, and GAC Group. Companies that produce new energy vehicles, such XPeng, BYD, Tesla, Li Auto, and NIO, are becoming more competitive by developing new technologies and tapping into new markets. To enhance market competitiveness and sustainability, businesses must address issues like excessive inventory and price volatility that have been brought about by the new energy vehicle market's explosive expansion through efficient financial risk management. The short- and long-term debt repayment capacities of traditional and new energy vehicle (NEV) enterprises are the main subjects of this study's analysis of their financial statements. According to the findings, traditional automakers have more stable financial circumstances whereas NEV enterprises exhibit stronger short-term solvency and lower long-term financial risk in specific years with superior liquidity and lower debt ratios. The study attempts to offer resources for the automobile industry's deleveraging, sustainable development, and inventory reduction.

Keywords: new energy vehicles (NEVs); financial risk; long-term solvency; short-term solvency; inventory reduction; deleveraging

1. Introduction

Every productive activity that an organization engages in has some risk, but financial risks are especially important. It is inevitable that the business will have financial risk as long as it has liabilities. We can efficiently monitor the financial risk of the business and quickly assess its financial condition via early warning and detection of financial danger. Financial indicators enable the research to more accurately depict the enterprise's financial risk. Numerous academics both domestically and internationally have studied company financial risk detection and prevention in great detail from various angles. A growing number of academics are turning to multiple indicator systems to assess financial risk more thoroughly, as single indicators have limits that make it difficult to fully capture the capital structure and operational circumstances of businesses. These multi-indicator

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* Corresponding: Chap Sovanhangmeas (sovanhangmeas.chap@gmail.com)

systems increase the efficacy of risk management by providing a more thorough and accurate assessment of an organization's financial health. Numerous academics also do early warning studies and financial state analyses of businesses using non-statistical approaches. These approaches are inclusive and encompass a range of concepts and strategies. In their evaluation of the use of artificial neural networks in financial forecasting, for instance, ANN has several benefits when handling complicated data patterns and nonlinear correlations, as noted by Xian Liu and Hao-Long Liu [1]. The B-S option pricing model was employed to evaluate whether a firm is experiencing a financial crisis, as demonstrated by Jiang X [2]. A research on the assessment of business financial risk using fuzzy comprehensive evaluation techniques and hierarchical analysis was suggested by Wang Tao in 2024 [3]. An optical path transmission quality prediction method based on artificial neural network (ANN) loss function optimization was investigated, and the accuracy of the prediction model was improved by optimizing the loss function design, as discussed by Shi Yannan [4]. The GA-optimized ANN processing method obtains higher machining efficiency, though a certain degree of degradation occurs relative to the initial surface quality. Better machining performance can be achieved by adjusting the weighting coefficients, as noted by Feng Lei (2024) [5]. SVM and ANN were used to study the risk and early warning of listed enterprises, and the development of risk early warning management throughout history was reviewed, along with a systematic analysis of current domestic and international mainstream enterprise risk early warning models, as highlighted by Xinxin Xu [6]. The use of statistical techniques in early warning studies has increased among academics. In a study by Wang Qianyi (2019), a small and medium-sized international trade firm was chosen, and the risk of its financial position was assessed using the Z-score and F-score models after analyzing its development history, organizational structure, and industry status quo [7]. To assess the financial risk, a company's most recent financial records were examined using the Z- and F-score models Cao Jiahao (2023). According to the data, the Z-score model revealed considerable financial risk for the firm, while the F-score model indicated low financial risk in the initial years and a greater probability of bankruptcy in the last year [8]. The financial risk was evaluated and categorized using the effectiveness coefficient approach and the F-score model Zhang Jialao (2023). The study's findings demonstrated that the business is consistently exposed to financial risk, particularly in areas such as funding, investments, operations, and growth. Zhang recommended implementing matching control countermeasures, including enhancing market discovery and technological innovation, strengthening the analysis of investment benefits, optimizing the capital structure, upgrading the internal control system, and raising employee awareness of risk prevention [9]. The company's financial risks were assessed and compared using the financial indicator technique and the F-score model Gu Zhihao (2023). Additionally, the study determined and examined the reasons behind these financial risks [10]. A demand forecasting approach was developed using time aggregation as a carrier, based on the Z-score and F-score models, to screen and evaluate financial indicators Liu Wei Zhu De (2022). The study found that this method is more accurate and significant for research compared to the Z-score model [11]. An analysis of Azalea Automobile's financial risk was conducted using the Z-score model, the entropy value approach, and the effectiveness coefficient method He Jiongmei. The study revealed issues with the company's capacity to service debt, operate profitably, and grow. To help new energy automotive firms prevent and control financial risks, the study also suggested relevant coping mechanisms and the establishment of a financial risk early warning system [12]. The Z-score and F-score models were used to conclude that the financial risk is relatively low Wang Di (2018). To enhance the financial risk detection, analysis, and response capacity of businesses, corresponding solution strategies were proposed. These methods serve as a valuable benchmark for the financial risk management of companies that manufacture similar automobiles [13,14]. Our researchers have strengthened the model by incorporating crucial elements like cash flow to compensate for the original Z-score model's drawbacks. The F-score model was proposed by Zhang Jialao in 2023. Numerous empirical investigations have been carried out by other researchers utilizing statistical analytic techniques and univariate and multivariate discriminant models put forth by researchers domestically and internationally, respectively, to forecast and assess the financial risks of Chinese firms. The majority of academics both domestically and internationally build analytical models based on financial indicators, regardless of whether statistical techniques are applied for financial risk analysis. Effective solvency control is the cornerstone of corporate financial risk management. In order to undertake case studies, examine

the actual debt structures of eight domestic automakers, evaluate the impact of their financial leverage, and impartially estimate their debt risk, this article primarily applies the pertinent solvency indicators to the heavily indebted car sector. This will serve as a model for the "de-stocking," "de-leveraging," and development that is both sustainable and healthful in the automotive sector.

2. Current Situation of China's Automotive Industry

The automobile sector is experiencing both unparalleled possibilities and problems as China's economy transitions from double-digit high growth to single-digit medium-high growth. Environmental protection and the energy transition are putting pressure on the conventional automobile industry, which means it needs to constantly develop and adapt. With its advantages over existing cars and their minimal carbon footprint, new energy vehicles (NEVs) have emerged as a major area of future development. In this setting, new market positions and development strategies are sought after by NEV firms like NIO, BYD, Tesla, Li Auto, and XPeng, as well as traditional automotive heavyweights like SAIC Motor, BAIC Group, and GAC Group.

The market for new energy vehicles (NEVs) has grown quickly in recent years, drawing interest from both investors and customers. Nevertheless, the business also has to deal with issues including excessive inventories and volatile prices. The automobile industry is facing significant changes and transformation, much like the real estate sector did following a steep fall in sales and mounting inventory, which led to strategic reorganization. While newer NEV businesses like NIO, BYD, Tesla, Li Auto, and XPeng are steadily gaining market share and a competitive advantage through technology advancements and product quality improvements, established automakers like BAIC Group and GAC Group are aggressively entering the NEV industry.

The automobile sector needs to handle the crucial problem of inventory reduction in this process. In addition to requiring a large amount of corporate capital and putting financial strain on businesses, high inventory levels also run the danger of starting pricing wars, which can upset the equilibrium of the market and harm a brand's reputation. Major automobile businesses have used a number of inventory reduction initiatives in order to address this difficulty. For instance, they are actively entering foreign markets to find new sales channels, stepping up promotional activities by providing discounts to draw customers, and modifying production schedules and output reductions to manage stock levels. During this process, financial risk management has become very crucial. In order to improve their resilience and competitiveness in the market, companies need to make sure they can accurately and promptly identify risks and take appropriate action. In addition to assisting businesses in navigating market shifts, researching the development status and trends of the conventional and new energy vehicle sectors and investigating how efficient financial risk management techniques can increase corporate competitiveness also strongly support the industry's overall sustainable growth.

3. Overview of Traditional and New Energy Vehicles

Known as SAIC Motor, SAIC Motor Corporation Limited is a multi-sector operating company that works in passenger automobiles, commercial vehicles, financial services, foreign operations, automotive services and trade, and component manufacture. Several well-known brands, including SAIC Volkswagen, SAIC GM, SAIC GM Wuling, and Roewe, are owned by SAIC Motor. SAIC Motor has positioned itself strategically in the new energy vehicle and intelligent connected vehicle sectors in response to national policies in recent years. The business has made significant investments in technological R&D and has introduced a number of innovative energy vehicle products, including the MG EZS and the Roewe Marvel R. SAIC Motor's revenue in 2023 was RMB 744.705 billion, an increase of 0.1% from the previous year.

With a wide range of operations, the BAIC Group offers financial services, automotive services and trade, passenger automobiles, commercial vehicles, and component production. BAIC Motor, Beijing Hyundai, Beijing Benz, and BAIC New Energy are just a few of the brands that the firm controls. Being one of the major participants in China's NEV market, BAIC Group made early investments in the new energy vehicle industry. 2023 saw a 3.9% yearly growth in revenue for BAIC Group, totaling RMB 197.949 billion. RMB 0.38 represented the basic earnings per share. At the end of 2023, total assets were RMB 168.72 billion, a 3% decline from the previous year, while total equity was RMB 79.383 billion, a 1% gain. Beijing Automotive sold

1.042 million cars in 2023, a 7.3% increase over the previous year.

The business of GAC Group encompasses a wide range of industries, including finance, international business, automotive services and trading, parts production, passenger automobiles, and commercial vehicles. Several well-known brands, including GAC Honda, GAC Toyota, GAC Transqi, and GAC New Energy, are owned by the GAC Group. Notable is also GAC's advancement in the realm of new energy vehicles. The BAIC Group's overall revenue in 2023 increased by 3.93% to RMB129.706 billion. Sales volume of cars: 2.550 million pieces. At the end of 2023, total assets of 218.394 billion yuan represented a 15.05% rise over the previous year, while basic earnings per share of 0.42 yuan represented a 2% annual increase in total owners.

Driven by innovation, NIO Inc. is a leading Chinese and international electric vehicle manufacturer, standing out in both markets for its high-end goods, cutting-edge technology, and first-rate services. Under the ticker code NIO, it is traded on the New York Stock Exchange (NYSE). Thanks to its superior goods and services, NIO has established itself as a leader in the market for high-end electric vehicles. With a 12.9% yearly growth, the company's total revenue in 2023 was RMB 55.6179 billion. Revenue from car sales was RMB 49.2573 billion, an 8.2% increase over the previous year. There were RMB 12.44 in basic profits per share. Total assets reached RMB 147.383 billion at the end of 2023, up 21.94% from the previous year; total equity reached RMB 25.546 billion, a 7% annual gain.

Leading the way in the production of plug-in hybrid, internal combustion engine, and electric cars worldwide is BYD. Among the noteworthy models are the BYD Tang, Qin, Han, and Song. As part of its comprehensive offering of green energy solutions, the firm also produces electric buses, solar panels, and energy storage systems. With production facilities and sales networks located all over the world, BYD has continuously had some of the highest worldwide sales of new energy vehicles. The firm has a strong financial position, consistent sales and profit growth, and a market value that is among the highest in the worldwide new energy vehicle industry. It is listed on the Shenzhen and Hong Kong stock markets. BYD's total income in 2023 was RMB 602.315 billion, a noteworthy 42% yearly growth. Basic earnings per share increased significantly from RMB 5.71 to RMB 10.32 in the prior year. At the end of 2023, BYD had total equity of RMB 113.715 billion, up 28.6% from the previous year, and total assets of RMB 679.547 billion, up 37.6%.

Based in Palo Alto, California, Tesla, Inc. is a renewable energy and electric car corporation. Worldwide, Tesla maintains production sites and sales networks in several nations and areas. The Fremont facility in California and the Gigafactory Shanghai are two of its primary manufacturing locations. Tesla has become a dominant force in the worldwide electric car industry as a result of its recent growth in vehicle sales and market share. With a market value among the greatest in the worldwide car sector, Tesla is one of the companies whose stocks is listed on the Nasdaq Stock Exchange under the ticker code TSLA. With a 16% year-over-year rise, Tesla's total revenue in 2023 was RMB 707.6 billion (about USD 96.8 billion). The income generated by the sales of vehicles was RMB 602.4 billion, or around USD 82.4 billion. The basic profits per share came to 21.69 RMB (or around 3.12 USD). By the end of 2023, Tesla's total assets had increased to RMB 2,071 billion (about USD 290 billion), an 18% year-over-year rise, and its total equity had reached RMB 207.1 billion (around USD 28.9 billion).

Li Auto's (formally Li Auto Inc.) range-extended electric vehicle (EREV) technology sets it apart. Electric cars with an internal combustion engine to extend range when the battery runs low are known as EREVs. Li Auto, which is aimed at the mid-to-high end market, places a strong emphasis on extended range, excellent performance, and an intelligent driving experience. The corporation wants to draw customers in with cutting-edge technologies and superior goods. Li Auto's overall revenue in 2023 increased by 173% year over year to RMB 123.851 billion. Revenue from car sales was RMB 49.2573 billion, an 8.2% increase over the previous year. There were RMB 5.95 in basic profits per share. In 2023, the company's total assets increased by 65.79% to RMB 143.467 billion, while its total equity increased by 34% to RMB 60.575 billion.

He Xiaopeng, who is presently the Chairman of Xpeng Motors, and other individuals formed the company with the goal of creating smart electric vehicles that lead the way in both technological innovation and user experience. The business has built a robust network of contacts in the Chinese and international markets. Targeting the mid-to high-end electric car market, Xpeng Motors places a strong emphasis on competitive price,

excellent performance, and intelligent features. The organization wants to draw customers in with its cutting-edge technology and inventiveness. With the ticker code "XPEV," Xpeng Motors went public on the New York Stock Exchange (NYSE) in 2020, joining the global electric car market. Xpeng Motors saw a 14% rise in revenue year over year in 2023, totaling RMB 30.676 billion. The income from car sales was RMB 28.01 billion, up 13% from the previous year. Each share was worth RMB 5.96 in basic earnings. As of the end of 2023, the company's total assets amounted to RMB 84.162 billion, an 18% growth over the previous year, while its total equity was USD 3.6328 billion, a 2% decline.

4. Analysis of Debt Solvency Risks for Traditional and New Energy Vehicles—Based on Financial Statements

For ease of comparison, comparable companies in the same industry, including both traditional and new energy vehicle manufacturers, were selected as references. These include SAIC Motor, BAIC Group, GAC Group, NIO, BYD, Tesla, Li Auto, and XPeng.

4.1. Short-Term Solvency Analysis

The current ratio and the quick ratio are the metrics most frequently used to assess a company's short-term solvency. When a company's current ratio is empirically valued at about 2, it indicates that it has the potential to turn current assets into cash before short-term debt expires. When inventory with poor liquidity is excluded, the quick ratio roughly represents the ratio of current obligations to current assets. An empirical value of 1 is considered appropriate. The current and quick ratios of traditional and new energy vehicle companies in recent years are shown in Table 1.

Table 1. Short-term Solvency of Traditional and New Energy Vehicle Companies.

	Traditional Vehicles						**New Energy Vehicles**									
	SAIC Motor		**BAIC Group**		**GAC Group**		**NIO**		**BYD**		**Tesla**		**Li Auto**		**XPeng**	
Year-End	**Current Ratio**	**Quick Ratio**	**Current Ratio**	**Quick Ratio**	**Current Ratio**	**Quick Ratio**	**Current Ratio**	**Quick Ratio**	**Current Ratio**	**Quick Ratio**	**Current Ratio**	**Quick Ratio**	**Current Ratio**	**Quick Ratio**	**Current Ratio**	**Quick Ratio**
2023	1.13	0.31	1.06	0.24	1.31	0.42	1.22	0.18	0.66	0.18	1.73	0.24	1.57	0.14	1.51	0.21
2022	1.07	0.30	1.04	0.27	1.62	0.51	1.29	0.19	0.72	0.06	1.53	0.22	2.45	0.06	1.81	0.29
2021	1.13	0.42	0.94	0.31	1.25	0.32	2.18	0.27	1.26	0.07	0.43	0.06	4.33	0.05	2.71	0.22
2020	1.11	0.38	0.90	0.28	1.34	0.29	3.31	0.22	1.05	0.32	0.51	0.06	7.28	0.73	5.06	0.28
2019	0.28	0.38	0.94	0.27	1.37	0.22	0.52	0.28	0.99	0.56	1.13	0.15	1.08	0.26	1.50	0.40
2018	0.30	0.33	1.01	0.33	1.65	0.17	1.42	0.48	0.99	0.66	0.83	0.11	-	-	-	-

Based on the data from Table 1, there are significant differences in the short-term debt repayment capacities of various automotive companies. Tesla, Li Auto, and XPeng have higher current ratios, indicating stronger short-term debt repayment abilities, while BYD and BAIC Group have lower quick ratios, reflecting weaker short-term debt repayment capacities. This is illustrated in Figures 1 and 2.

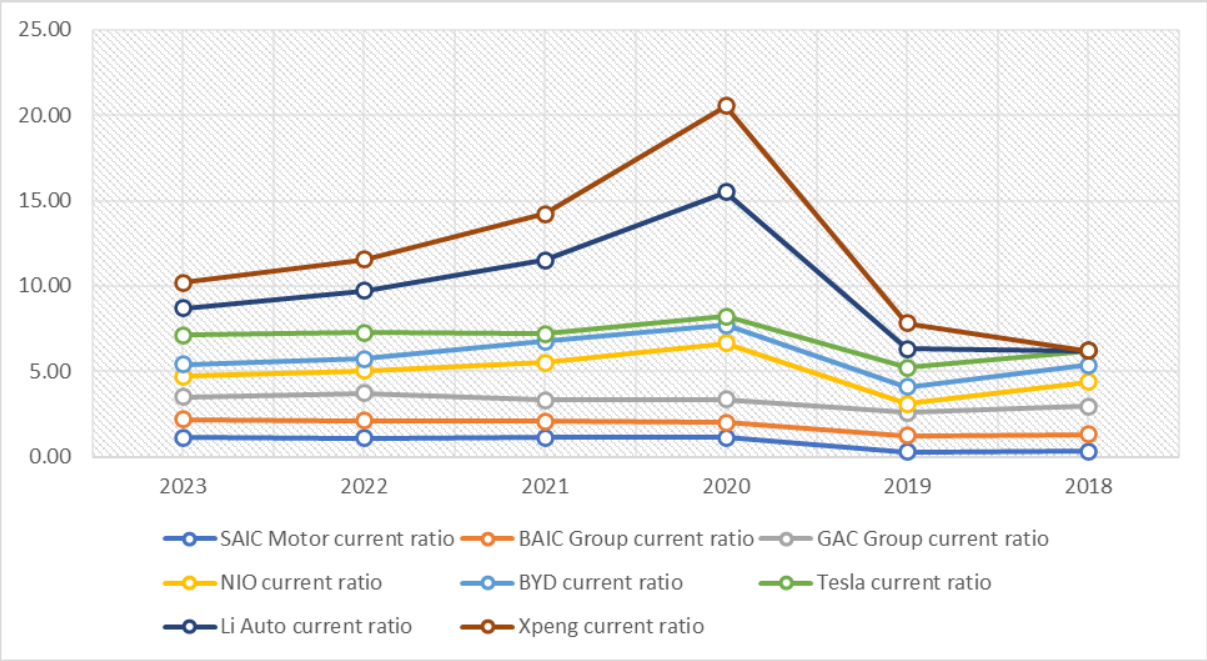

Figure 1. Changes in Current Ratios of Traditional and New Energy Vehicles.

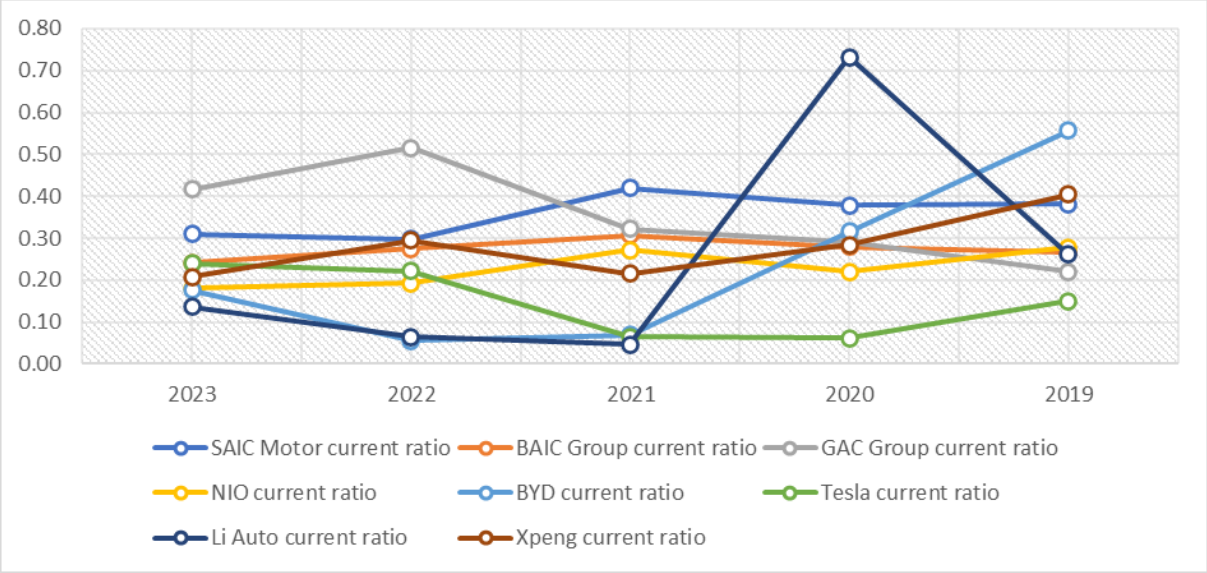

Figure 2. Changes in Quick Ratios of Traditional and New Energy Vehicles.

Table 1 and Figures 1 and 2 show that SAIC Motor Corporation's current ratio dropped to 0.28 in 2019, which is the lowest point ever, in 2019, suggesting a poorer capacity to repay short-term debt. The current ratio improved to 1.13 by 2023, indicating a better ability to repay short-term debt. The quick ratio grew to 0.42 in 2021 after being lower in 2018 and 2019, at 0.30 and 0.38, respectively, suggesting more liquidity. The BAIC Group's current ratio steadily improved as liquidity gradually improved, from a low of 0.90 in 2020 to 1.06 in 2023. Throughout the time, the quick ratio was comparatively constant, dropping from 0.33 in 2018 to 0.24 in 2023. The current ratio for GAC Group showed comparatively consistent liquidity, peaking at 1.65 in 2018 after reaching its lowest point of 1.25 in 2021. The quick ratio showed strong liquidity in several years, peaking at 0.51 in 2022 and falling to 0.17 in 2018. NIO's current ratio showed a notable short-term increase in liquidity, peaking at 3.31 in 2020 and falling to 0.52 in 2019. The fast ratio indicated decreased liquidity in various years; it peaked at 0.48 in 2018 and fell to 0.18 in 2023. BYD's current ratio varied throughout time, peaking at 1.26 between 2018 and 2021 and then falling to 0.66 in 2023. The quick ratio showed very low quick assets in 2020 and 2022, peaking at 0.66 in 2019 and falling to 0.06 in those same years. Tesla's current ratio showed a progressive improvement in liquidity, peaking at 1.73 in 2023 and down to 0.43 in 2021. With fewer fast assets

in those years, the quick ratio peaked in 2023 at 0.24 and fell to 0.06 between 2020 and 2021. Li Auto's current ratio peaked at 7.28 in 2020 and was zero in 2018, indicating a significant improvement in liquidity in the short term. The quick ratio was highest at 0.73 in 2020 and zero in 2018, showing a significant increase in quick assets. XPeng's current ratio was highest at 5.06 in 2020 and zero in 2018, indicating a notable increase in liquidity in the short term. The quick ratio peaked at 0.40 in 2019 and was zero in 2018, reflecting increased quick assets. It is clear from comparing these automakers' current and quick ratios that new energy vehicle companies—like NIO, Li Auto, and XPeng—showed particularly strong liquidity in several of these years. Traditional automakers, on the other hand, including SAIC, BAIC, and GAC, showed more steady liquidity with little swings, indicating a more cautious financial posture. Leading worldwide manufacturer of new energy vehicles, Tesla, likewise exhibits a year-over-year trend of increasing cash, demonstrating sound financial standing.

4.2. Long-Term solvency

Long-term solvency is primarily measured by two indicators: the debt-to-asset ratio and the equity ratio. The debt-to-asset ratio is a comprehensive metric used to evaluate a company's debt level and long-term solvency. A higher debt-to-asset ratio indicates a heavier debt burden and weaker solvency, while a lower ratio suggests a lighter debt burden and stronger solvency. The debt-to-asset ratios of traditional automotive companies and new energy vehicle companies in recent years are shown in Table 2.

Table 2. Debt-to-Asset Ratios of Traditional Automotive and New Energy Vehicle Companies.

Year-End	SAIC Motor	BAIC Group	GAC Group	NIO	BYD	Tesla	Li Auto	XPeng
2018	0.033	0.025	0.012	0.062	0.332	0.739	0	0
2019	0.031	0.009	0.013	0.491	0.388	0.388	0.025	0.183
2020	0.033	0.014	0.021	0.109	0.386	0.386	0.014	0.037
2021	0.037	0.021	0.018	0.028	0.064	0.064	0.097	0.026
2022	0.041	0.015	0.026	0.113	0.026	0.026	0.111	0.065
2023	0.057	0.024	0.041	0.111	0.018	0.403	0.012	0.067

As shown in Table 2, since 2018, the long-term solvency of various companies has fluctuated over this period. Some companies have shown a stable growth trend, while others have experienced greater financial pressure and volatility, as illustrated in Figure 3.

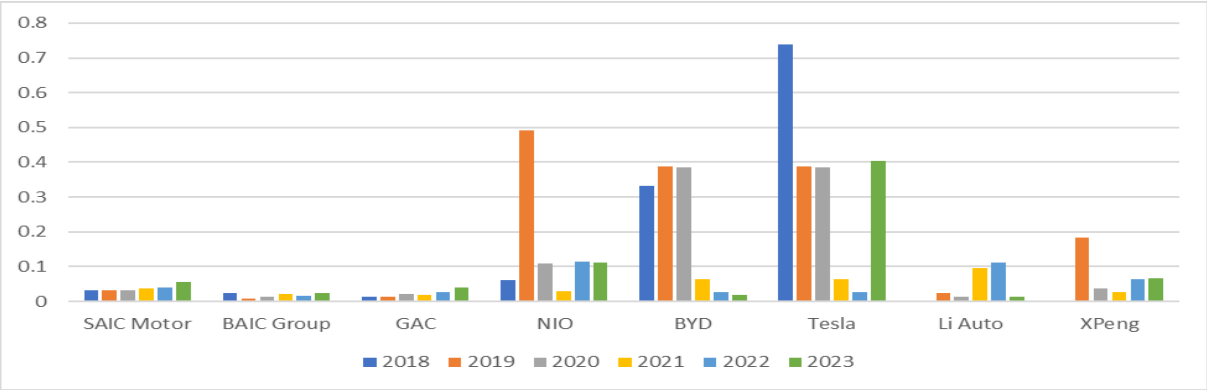

Figure 3. Debt-to-Asset Ratios of Traditional Automotive and New Energy Vehicle Companies.

Based on the statistics, we can see that SAIC Motor's long-term solvency has improved year over year, suggesting a stronger financial position. The solvency of the BAIC Group fluctuated throughout time, bottoming

out in 2019 before rising again, maybe as a result of financial strain in certain years. The long-term solvency of GAC Group has increased yearly, demonstrating notable advancements in strengthening financial stability. NIO's solvency increased in 2019 but then fluctuated, presumably as a result of the business's growth and investment operations. After peaking in 2018, BYD's long-term solvency has been steadily declining, suggesting possible financial hardship. Tesla's solvency fluctuated a lot, peaking in 2018, falling in the years that followed, and then rising in 2023. Data for XPeng and Li Auto began in 2019, with XPeng's solvency exhibiting a reasonably consistent growth pattern and Li Auto's solvency showing a considerable surge in 2021 and 2022 before falling.

4.3. Equity Ratio

The equity ratio reflects the degree of protection that shareholders' equity provides to creditors' equity. The higher the ratio, the weaker the company's long-term solvency, and vice versa. The equity ratios of traditional automotive and new energy vehicle companies in recent years are shown in Table 3.

Table 3. Equity Ratios of Traditional Automotive and New Energy Vehicle Companies.

Year-End	SAIC Motor	BAIC Group	GAC Group	NIO	BYD	Tesla	Li Auto	XPeng
2018	36%	36%	59%	36%	91%	75%	0%	0%
2019	35%	42%	60%	−43%	29%	19%	−60%	18%
2020	34%	38%	61%	50%	28%	43%	82%	4%
2021	36%	41%	60%	42%	20%	47%	66%	3%
2022	34%	46%	64%	25%	25%	54%	52%	6%
2023	34%	47%	57%	22%	22%	25%	42%	7%

As shown in Table 3 The comparatively high equity ratios of BYD and GAC Group suggest a higher dependence on loan financing. On the other hand, XPeng's equity ratio is lower, indicating a greater dependence on equity funding. The notable oscillations in the equity ratios of NIO and Li Auto underscore the fiscal difficulties and adaptations that these nascent automobile enterprises encounter as they grow and mature.

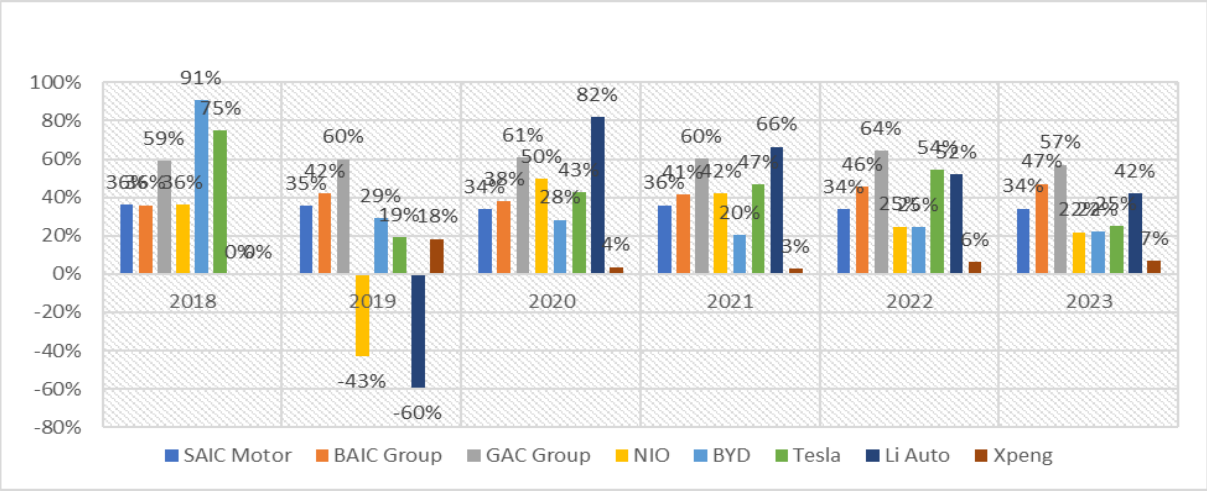

Figure 4. Equity Ratios of Traditional Automotive and New Energy Vehicle Companies.

As shown in Figure 4 The financial leverage reflects the extent to which a company uses debt to increase its capital. The range of 34% to 36% for SAIC Motor's equity ratio indicates that the firm has kept its degree of financial leverage largely constant. The business has demonstrated responsible use of financial leverage by keeping its debt and shareholders' equity in balance. The equity ratio of BAIC Group grew from 36% in 2018 to

47% in 2023, demonstrating that while the company has raised its financial leverage, the percentage of debt it possesses has also climbed. The variability of GAC Group's equity ratio, which ranged from 59% to 64%, indicated a greater dependence on debt funding. In 2023, NIO's equity ratio dropped from 91% in 2018 to 22%. The corporation may have suffered large losses or a spike in debt in 2019 based on the negative equity ratio. The company's financial leverage has dramatically dropped since then, indicating efforts to lower debt and enhance capital structure. In 2018, the equity ratio of Tesla was 75%; it fell to 19% in 2019, increased to 54% in 2022, and then decreased to 25% in 2023. Over time, Tesla's financial leverage has fluctuated, indicating that the business has implemented varied debt management techniques in response to shifting market and financial situations. Li Auto's 2019 equity ratio was negative (-60%), showing that the business could have had large losses or a spike in debt during that year. The equity ratio then steadily increased to 42% by 2023. In 2019, XPeng's equity ratio was comparatively low at 18%, and it continued to hover between 4% and 7% in the subsequent years. The low equity ratio suggests that XPeng used financial leverage more sparingly and depended less on debt during this time.

5. Analysis of Debt Solvency Risks for Traditional and New Energy Vehicles—Based on Perpetual Bond Financing

5.1. Market Ratings of Traditional and New Energy Vehicles

SAIC Motor has used a number of financing strategies, such as capital market financing and bank loans, to obtain money. These strategies are based on the financial statements and market performance of significant automakers. Regarding bank loans, SAIC Motor has forged alliances with financial institutions to secure the long- and short-term financing required to fulfill its investment and operating requirements. Usually, the corporation uses these loans to fund its expansion goals, project investments, and day-to-day operations. Bank loans are a vital source of financing for businesses, particularly when substantial financial assistance is needed. This is because they may offer a rather reliable source of finance. SAIC Motor aggressively seeks funding from the financial markets at the same time. In order to finance its growth and development, the corporation issues bonds, stocks, and other financial instruments. One example of how the corporation uses capital markets to finance technical innovation and commercial growth is SAIC Motor Financial Management Co., Ltd., which publicly issued technology innovation bonds to professional investors. After conducting a follow-up analysis and evaluation of SAIC Motor Financial Management Co., Ltd.'s and its related bonds' credit status, United Ratings assigned a credit rating of AAA to both the "23 Shangjin K1" and "23 Shangjin K2" bonds, with a stable rating outlook, and maintained the company's long-term credit rating of AAA.

BAIC Group, as a prominent state-owned firm in China, has forged robust connections with local banks and possesses seamless financing channels in both domestic and international capital markets. The BAIC Group manages its liquidity well by having a surplus of cash and cash equivalents as well as unused bank credit lines. BAIC Group's long-term issuer default rating (IDR) and foreign currency senior unsecured rating have been upgraded to "BBB+." Moreover, BAIC Motor Corporation Limited (HKSE: 01958), a part of the BAIC Group, has maintained its long-term IDR and foreign currency senior unsecured rating at "BBB+," with a stable rating outlook, according to Fitch Ratings. BAIC Group's rating is closely linked to Fitch's internal assessment of the credit status of the Beijing municipal government, reflecting the strong association between the company and the local government. Given the close operational and strategic ties between BAIC Motor and its parent company BAIC Group, Fitch has aligned BAIC Motor's rating with that of BAIC Group using a top-down approach in accordance with its "Parent and Subsidiary Linkage Rating Criteria."

In the critical period of transformation in the automotive industry, GAC Group has adopted a strategy that combines both "aggressive" and "conservative" approaches. This strategy is reflected in its focus on investing in key technologies, where GAC not only emphasizes the application of "three-electric" (battery, electric motor, and electric control) and smart technologies but also actively promotes talent development and innovation in mechanisms. The company has invested heavily in achieving rapid updates and iterations in technology and products, while also using bank loans to support daily operations and project investments, a common financing

method. Additionally, GAC Group actively leverages capital market financing, raising funds through the issuance of bonds and stocks. This not only helps the company gain more financial support but also enhances its market position and overall competitiveness. In 2023, GAC plans to distribute approximately RMB 1.57 billion in dividends with a payout ratio of 36%, continuing its tradition of maintaining an annual payout ratio above 30% since its listing in 2012. Moreover, the company announced for the first time a plan to repurchase A-shares and H-shares, with a total repurchase amount ranging between RMB 500 million and RMB 1 billion, of which the H-share repurchase will range between RMB 400 million and RMB 800 million. In terms of capital allocation, GAC Group has taken a cautious approach. Despite its active market operations, its valuation in the Hong Kong stock market is only 0.27 PB and 7.0 PE, highlighting a significant gap in its market capitalization and valuation compared to its peers. This level of valuation does not fully reflect the company's potential and actual value in the market.

NIO, which has been facing high debt risks, recently secured a strategic investment that has eased its short-term cash flow pressures. At the time of NIO's IPO, 50 million shares were placed in a user trust. Although these shares remain on the equity register, the trust is no longer the largest economic shareholder. However, due to its super-voting rights, the trust still holds the most significant voting power, resulting in minimal changes at the shareholder voting level. As of December 2022, when the investment transaction was completed, CYVN acquired the right to nominate two directors to NIO's board, provided it maintains a beneficial ownership of at least 15% of NIO's outstanding shares. If CYVN's ownership falls below 15% but remains above 5%, it retains the right to nominate one director. Several market experts have noted that, despite the current challenging investment environment, NIO's ability to attract funding from Middle Eastern investors reflects the value of its brand and CEO Li Bin's standing in the capital markets. Following NIO's earnings report, several investment banks, including Deutsche Bank, Citibank, Crédit Lyonnais, and Mizuho Securities, gave NIO a "buy" rating. Deutsche Bank highlighted NIO's strong second-quarter performance, particularly its gross margin, and gave an optimistic outlook for the third quarter. Citibank analysts expect NIO's deliveries to increase monthly from October through December, potentially reaching new highs. Crédit Lyonnais noted that the delivery of the ET5 model could significantly boost NIO's sales and stock price. Given its innovation and market potential, NIO's credit rating in the capital markets could range between BB+ and BBB, indicating a relatively positive market outlook.

According to BYD's 2023 financial report, the company outperformed its former competitors in the domestic market, showcasing strong competitiveness in both sales and financial performance. BYD reached record highs in key metrics such as revenue, profit, R&D investment, and cash flow. The issue of "increasing revenue without increasing profit," which had been a concern in the past, was effectively resolved this year. In 2023, BYD continued to strengthen its leadership in the new energy vehicle (NEV) market and formed a strategic partnership with Uber to introduce 100,000 BYD electric vehicles for global shared mobility services. According to its annual report, BYD remains the most profitable among A-share listed automotive companies, solidifying its position as an industry leader. In a highly competitive market, BYD has become a well-run industry giant with few domestic competitors. Using the Discounted Cash Flow (DCF) model, BYD's intrinsic stock value is estimated at RMB 204 per share. The Price-to-Earnings (P/E) ratio valuation model places the stock price at RMB 137 per share. By averaging these two figures, a more reasonable target price of RMB 170 per share is obtained. Considering the current competitive market environment, a recommended safety margin of 30% suggests a final target price of RMB 119 per share.

Based on the financial statement data, Li Auto's performance can be described as "thriving." The strong support from the Chinese government for new energy vehicles and the subsequent surge in consumer demand for electric vehicles have helped Li Auto establish a foothold in the market, gradually overcoming the challenges of its startup phase. The successful listing of Li Auto on Nasdaq further accelerated the company's business expansion, showcasing a prosperous scene. Haitong International has maintained an "Outperform" rating for Li Auto, with a target price lowered to HKD 149.8. Morgan Stanley has reduced its 2024 sales forecast for Li Auto by 15% due to lower-than-expected demand rebound following the facelift of the L series models and also lowered its 2025 sales forecast by 14%. The firm maintains an "Overweight" rating for Li Auto but has reduced

the target price by 14% to HKD 233. Additionally, Li Auto has become the first Chinese automotive company to receive the highest MSCI ESG rating of "AAA," demonstrating excellent performance. However, Li Auto still needs to improve its social and governance scores to further enhance its overall ESG score.

Tesla's market performance in 2023 can be characterized as "stellar amidst high volatility." Following the release of its financial statements early in the year, capital markets reacted in starkly different ways. U. S. investment firms like Morgan Stanley, Goldman Sachs, and Citigroup gave Tesla a "buy" or "overweight" rating. Morgan Stanley's analyst Adam Jonas and his team were particularly optimistic, setting a target price of $310, suggesting a potential 40% increase in Tesla's stock price. In contrast, international investment banks such as Credit Suisse, BNP Paribas, and Nomura took a more cautious stance, issuing "sell" or "hold" ratings and lowering their target price to around $150. In 2023, Tesla's credit rating was upgraded by Standard & Poor's, reflecting growing confidence in its financial stability and business outlook. S&P highlighted Tesla's significant progress in reducing debt, improving profitability, and expanding its market share, leading to a credit rating upgrade from "B+" to "BB-." This upgrade indicates growing investor confidence in Tesla's continued growth and solidifies its position in the global electric vehicle market.

Volkswagen recently announced a $700 million investment in XPeng Motors, acquiring a 4.99% stake and planning to co-develop two electric vehicle models. Volkswagen will utilize XPeng's "Edward" platform for these new models and will begin paying for technology services next year, breaking from the traditional technology licensing model. Following this news, XPeng's stock surged, with its U.S. shares rising 26.69% and its Hong Kong shares climbing 33.88%, reaching a one-year high, though still below historical peaks. Despite these significant stock gains, Chinese financial institutions have expressed skepticism about the partnership, which was initially expected to disrupt the new energy vehicle sector. Bank of Communications International downgraded XPeng's rating to "Sell," citing an "overreaction" to the stock price and setting a target price of HKD 39.3 / USD 10.5. Currently, XPeng's U. S. and Hong Kong shares are trading at more than double that target price. In contrast, Huatai Securities has maintained a "Buy" rating for XPeng and raised its target price for the company's Hong Kong shares to HKD 92.46. International banks, however, have generally reacted positively to the partnership. UBS has given XPeng a "Buy" rating, stating that the partnership will boost market confidence. Morgan Stanley highlighted the strategic importance of this collaboration between a global automotive giant and a domestic electric vehicle startup, which could pave the way for Chinese automakers to expand overseas. They rated XPeng as "Overweight." Citi also expressed optimism, supporting the positive outlook on the partnership.

5.2. Analysis of Debt Solvency Risks for Traditional and New Energy Vehicles

Perpetual bonds are a type of bond with no fixed maturity date (typically exceeding 30 years) but require periodic interest payments. From this perspective, perpetual bonds are a financing instrument that lies between debt and equity, often referred to as "stocks in the form of bonds." In the event of corporate bankruptcy and liquidation, creditors can only demand repayment of the principal, with their claims ranked lower than common and preferred shareholders, meaning they are positioned further down the repayment hierarchy. Therefore, perpetual bonds typically demand higher returns. Generally, companies choose this type of financing only when the financing environment is extremely challenging and they have no other viable options.

SAIC Motor, BAIC Group, GAC Group, NIO, BYD, Tesla, Li Auto, and XPeng have all used perpetual bonds, but the scale varies among these companies. For traditional automakers (SAIC Motor, BAIC Group, GAC Group), the interest rates paid on perpetual bonds are generally around 4% to 6%. For emerging electric vehicle companies (NIO, Li Auto, XPeng), the interest rates are typically between 6% and 8% or higher. BYD and Tesla fall between these two categories. As a mature new energy company, BYD's rates are approximately 5% to 7%. Tesla, being a leading global electric vehicle company, despite having strong market confidence, faces higher capital demands and rapid business expansion, with interest rates generally around 5% to 7%. SAIC Motor issued RMB 20 billion in perpetual bonds for the first time in August 2023. Therefore, as of 2023, the scale of SAIC Motor's perpetual bonds is RMB 20 billion. BAIC Group issued perpetual bonds for the first time in 2019, amounting to RMB 5 billion. As of 2023, the total scale of BAIC Group's perpetual bonds is

approximately RMB 15 billion. GAC Group issued perpetual bonds for the first time in 2020, with an initial amount of RMB 8 billion. As of 2023, the total scale of GAC Group's perpetual bonds is approximately RMB 12 billion. BYD issued perpetual bonds for the first time in 2022, amounting to RMB 10 billion. As of 2023, the scale of BYD's perpetual bonds is RMB 10 billion. As of 2023, NIO, Li Auto, XPeng, and Tesla have not issued perpetual bonds, so there are no related amounts or scales available. Interest paid to perpetual bondholders by SAIC Motor, BAIC Group, GAC Group, NIO, BYD, Tesla, Li Auto, and XPeng is not included in interest expenses but is recorded as equity. The accounting treatment of perpetual bonds makes them appear as "invisible" debt on financial statements, which might obscure the company's true debt levels and repayment pressures. While this treatment might make the company's financial health look better, investors and creditors still need to pay attention to the actual repayment capacity and cash flow to fully assess the company's financial risk.

According to research reports from Deutsche Bank and other foreign investment banks, incorporating debt into the debt calculations shows a significant increase in SAIC Motor's net debt ratio. Specifically, considering perpetual bonds, SAIC Motor's net debt ratio could reach as high as 65.94%. BAIC Group's net debt ratio is estimated to be 63.69%. GAC Group's debt ratio stands at 43.04%, indicating increased financial leverage risk. NIO's net debt ratio is 80%. BYD's net debt ratio is 77.14%. Li Auto's net debt ratio has been rising annually, climbing from a relatively low level in 2020 to 57.78% in 2023. XPeng's debt ratio is 59%. NIO and BYD have higher net debt ratios, indicating greater financial leverage risk. SAIC Motor and BAIC Group also have high debt ratios, though slightly lower than the former two. GAC Group faces increased financial leverage risk, while Li Auto and XPeng's debt ratios have been rising annually, reflecting growing financial pressure on each company. To mitigate future debt risks, companies issuing perpetual bonds typically redeem a portion of their debt in advance, which also imposes significant financial pressure. Considering the factors involving perpetual bonds, it is noted that SAIC Motor, BAIC Group, GAC Group, Tesla, Li Auto, and XPeng have not issued perpetual bonds, whereas NIO has issued perpetual bonds with a total principal amount of $1 billion, pricing convertible preferred bonds with a principal amount of $500 million due in 2029 and another $500 million due in 2030. This financing is significant for NIO, as it not only enhances its financial strength but also provides funding for future R&D, production, and market expansion. BYD has issued perpetual bonds totaling up to RMB 5 billion. Through these perpetual bonds, BYD can secure a long-term, stable source of funds to support its ongoing technology development and market expansion, further consolidating and enhancing its leading position in the industry. Additionally, when looking at gross profit margins, the profitability levels of SAIC Motor, BAIC Group, GAC Group, NIO, BYD, Tesla, Li Auto, and XPeng over recent years show significant differences, as illustrated in Figure 5.

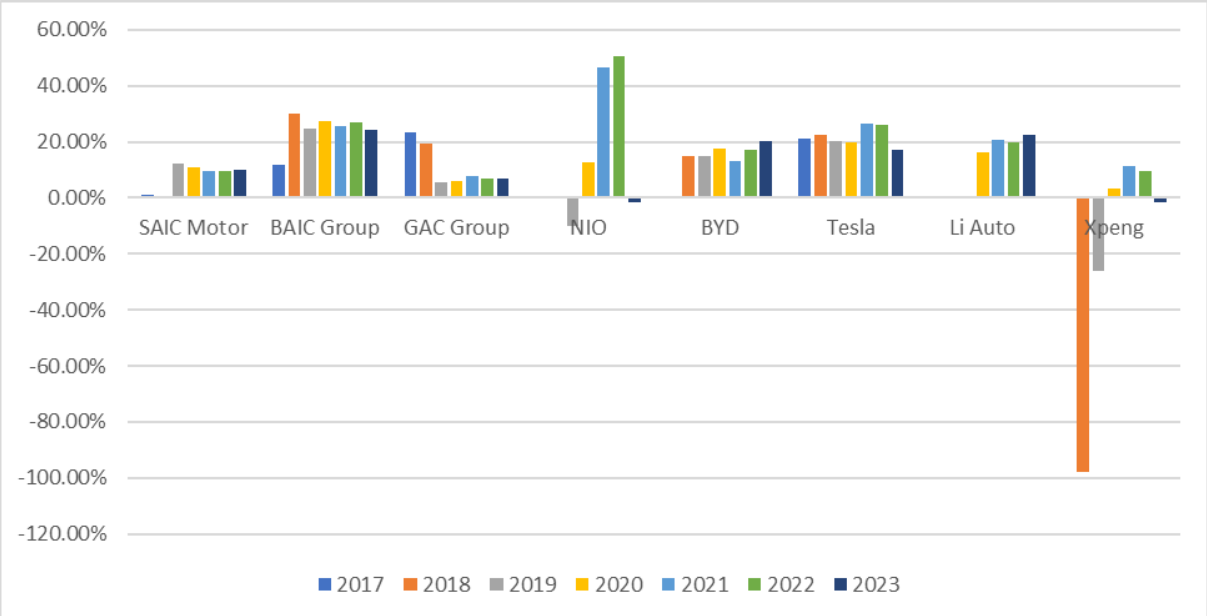

Figure 5. Gross Profit Margin of Traditional and New Energy Vehicles.

From Figure 5, it can be seen that between 2017 and 2023, SAIC Motor's gross profit margin remained relatively stable. Although it peaked at 12.15% in 2019 and then slightly declined, it still stood at 10.19% in 2023. This stable gross profit margin reflects SAIC Motor's maturity in cost control and its solid market position. BAIC's gross profit margin surged to 29.88% in 2018 and remained between 24% and 27% over the next few years. Despite a slight decrease to 24.23% in 2023, the overall gross profit margin remains high, indicating BAIC's cost advantages in production and sales processes. GAC Group's gross profit margin started declining from 23.46% in 2017, falling to 5.55% in 2019. Although it recovered somewhat, it was still relatively low at 6.94% in 2023. This suggests that GAC Group faces certain challenges in market competition and cost control. NIO's gross profit margin exhibits significant volatility. It was zero or negative in 2017 and 2018, and -9.89% in 2019. However, from 2020 onwards, NIO's gross profit margin significantly improved, reaching 46.54% in 2021, but fell back to -1.60% in 2023. This sharp fluctuation indicates cost management issues faced by NIO during rapid expansion. BYD's gross profit margin has been increasing year by year since 2018, reaching 20.21% in 2023. This trend reflects BYD's continued improvement in production efficiency and cost control, with particularly notable performance in the new energy vehicle sector. Tesla's gross profit margin remained relatively stable between 2017 and 2023. Although it decreased to 17.05% in 2023, the overall gross profit margin remains high, showing Tesla's cost control and pricing advantages in the electric vehicle market. Li Auto's gross profit margin has been gradually rising since 2019, reaching 22.73% in 2023, demonstrating Li Auto's growing maturity in the market and significant improvement in profitability. In contrast, XPeng's gross profit margin has been very unstable, with negative values in 2018 and 2019, and falling back to -1.60% in 2023. This indicates that XPeng needs to further enhance its cost structure and market competitiveness. Combining these analyses, companies with high gross profit margins, such as BYD, Tesla, and Li Auto, generally exhibit strong profitability and stable cash flows. This enables them to secure financing at lower interest rates due to their solid financial positions and lower debt risks. On the other hand, companies with lower or more volatile gross profit margins, such as GAC Group, NIO, and XPeng, may face higher financing costs. Poor or fluctuating gross profit margins increase financial uncertainty, leading creditors to demand higher interest rates to mitigate risks or imposing stricter financing conditions on these companies.

6. Insights and Recommendations

The above study indicates that different automotive businesses demonstrate varying performances about their capacity to repay long-term debt and their level of financial leverage. BAIC Group ‘s debt has increased, GAC Group is dependent on debt financing, NIO is trying to lower its debt, BYD is having financial difficulties, Tesla's debt management strategy is erratic, Li Auto's financial situation is gradually getting better, and XPeng employs a cautious debt management strategy. In contrast, Shanghai Automotive is steadily improving. While BYD and BAIC Group score rather poorly, Tesla, Li Auto, and XPeng demonstrate great performance in terms of short-term loan repayment capabilities. The following cautions for the automobile sector on “inventory reduction” and “de-leveraging” are revealed by the debt risk analysis for SAIC Motor, BAIC Group, GAC Group, NIO, BYD, Tesla, Li Auto, and XPeng:

(1) High-leverage firms, such as GAC Group, are vulnerable to severe payback pressure in the event of a change in market conditions, such as a downturn in sales or increased financing costs. These organizations have achieved quick expansion with extensive borrowing. High-leverage businesses must exercise caution to prevent taking on excessive financial risk as a result of blind expansion, particularly in light of the growing unpredictability of the global economy. Businesses should improve their debt management strategies, limit leverage levels in a reasonable manner, and make sure that financial leverage is steady despite changes in the economy.

(2) Inventory Control: An essential function in the capital-intensive automotive sector is inventory control. Having too much inventory may lock up a lot of capital, which can cause problems with cash flow and put more strain on financial debt. To reduce financial risk, businesses like Beijing Automotive and BYD must quickly modify inventories in reaction to poor market demand or supply chain interruptions. Achieving better financial circumstances, lowering capital occupancy, and relying less on outside funding are all made possible by efficient

inventory management.

(3) Debt Structure Optimization: NIO and Li Auto serve as examples of how crucial it is to optimize debt structure by gradually reducing debt. Improving a company's debt structure reduces expenses while strengthening its defense against risk. Prioritizing retained profits and equity financing can help businesses boost capital while lowering their reliance on expensive debt and lowering their risk of financial strain. Furthermore, looking into ways to prolong debt maturities, including issuing convertible or long-term bonds, might lessen the need to make repayments quickly.

(4) Adaptable Debt Management: Tesla's approach to debt management highlights the necessity of adaptability in terms of debt and inventory adjustments in response to market swings. Because high-leverage organizations are more vulnerable to shifts in the economy or industry cycles, having flexible finances is essential. To reduce the impact of market swings, businesses should modify their capital structure and debt levels in accordance with the state of the economy and market demand. During periods of elevated market demand volatility, enhancing cash flow management and augmenting liquidity are vital for promptly addressing external obstacles.

(5) Short-Term Debt Repayment Capacity: This is a vital sign of a business's capacity to manage debt. Businesses like XPeng that have higher liquidity ratios demonstrate a greater capacity to repay debt in the near term and are better equipped to handle debt pressure. Conversely, businesses with lower fast ratios, like Beijing Automotive and BYD, exhibit susceptibility when it comes to short-term debt repayment and may run into financial issues when faced with restricted cash flow. To handle the strain of short-term debt, businesses must thus retain enough liquidity during the deleveraging process. Financial crises brought on by a lack of liquidity can be averted by strengthening short-term repayment capacity and improving cash management.

(6) Synchronized Intermediate- and Long-Term Plans: Companies should coordinate both short- and long-term objectives during the "inventory reduction" and "de-leveraging" operations to maintain sustainable development and financial health. Long-term capital structure optimization and a decrease in reliance on expensive debt are essential, but short-term liquidity needs must be met to manage unforeseen market fluctuations. During the "inventory reduction" and "de-leveraging" processes, businesses can achieve financial stability and sustainable growth by striking a balance between long-term steady development and short-term flexibility.

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References

1 Ma H. Debt Risk Analysis of Real Estate Enterprises—A Case Study of "Hengda Real Estate". *Journal of Shaan xi Xueqian Normal University* 2016; (**08**): 22–26.

2 Liu X, Liu H. The Application of ANN-FLUS Model In Reconstructing Historical Cropland Distribution Changes: A Case Study of Vietnam from 1885 to 2000. *Journal of Natural Resources* 2024; **39**(**6**): 1473–1492

3 Liang J, Liu W. The Impact of Innovation Capability on Financial Performance in the New Energy Vehicle Industry-An Empirical Study of Listed Companies in China. *Review of Industrial Economics* 2023; (**06**): 5–26.

4 Song Y. Discussion on the Feasibility Analysis of Financial Data of the Automotive Industry under the Dimension of OTA Technology and Policy to Help Vehicle Consumption—Taking Tesla as an Example. *Auto Time* 2023; (**22**): 183–185+198.

5 Feng L. Parameter Optimization of End Face Robot Die Forging Based on GA Optimization ANN Method. *Forging Equipment and Manufacturing Technology* 2024; **59**(**03**): 99–101.

6 Pauwels K, Silva-Risso J, Srinivasan S, et al. New Products, Sales Promotions, and Firm Value: The Case of the Automobile Industry. *Journal of Marketing* 2004; **68**(**4**): 142–156.

7 Kumar G, Maqbool J. Financial Technology in the Automobile Industry. *Proceedings of the Applied Management Conference* 2018; **1**(**2**).

8 Dai L. Study on Financial Competitiveness of Listed Companies in New Energy Vehicle Industry—BYD as an Example. *Advances in Economics*, *Management and Political Sciences* 2023; **30**: 94–102.

9 Xu X. Construction of Financial Early Warning Model forListed Enterprises Based on SVM and ANN. *Techniques of Automation and Applications* 2021; **40**(**05**):171–174.

10 Huang H, Jiang W, Wang S. Research of Financial Early-Warning for Listed Companies Based on SVM. In Proceedings of the 2015 International Conference on Computational Science and Engineering, Qingdao, China, 20–21 July 2015; pp. 278–281.

11 Yan X, Zhou Q. Research on Financial Development Capability of Listed Companies Based on Multiple Regression Model—Take BYD as an Example. *Academic Journal of Business & Management* 2022; **4**(**11**).

12 He Y, Rachev S. Exploring Implied Certainty Equivalent Rates in Financial Markets: Empirical Analysis and Application to the Electric Vehicle Industry. *Journal of Risk and Financial Management* 2023; **16**(**7**): 344.

13 Qian J. Research on Financial Risk Assessment of Xiaopeng Motors. *E-Commerce Letters* 2024; **13**: 5024.

14 Tao W. Research on Financial Risk Issues in the New Energy Vehicle Industry: Taking C Automobile Company as an Example. *Modern Management* 2024; **14**: 2089.

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Article

Modern Management Accounting Enables Enterprise Organization and Social and Economic Development

Jingtao Wu * and Yuanyuan Luo

Hubei Accounting Society Research Group, Hubei Huaren Zhiyuan Accounting Firm (General Partnership), Xiangyang 441005, China

Abstract: Modern management accounting provides a powerful tool for the expansion of financial accounting function, but also provides an important support for the development of enterprise organizations and social and economic development. This paper expounds how modern management accounting can better empower enterprise organization and social and economic development from three dimensions of historical research, realistic dilemma and future prospect.

Keywords: modern management accounting; development of enterprise organization; social and economic development

1. Historical Investigation of the Management Accounting Function

The two functions of management accounting information support and management control can strengthen the management cooperation, information transparency and sharing in research and development, production and other processes, reduce the information asymmetry of enterprises, and improve the management and control ability of enterprises.

Agency theory holds that management control as a management accounting function can reduce the opportunistic behavior of agent by reducing the information asymmetry between principal and agent. As a management control system, management accounting can, on the one hand, plan, refine and control the analysis of value drivers; on the other hand, the management control function can help enterprises improve service quality and customer satisfaction, acquire new customers and increase market share and customer loyalty. Wang Bin and others believe that the management control function helps the organization to set goals and select action plans, identify specific value drivers, and allocate the resources needed to achieve enterprise value creation [1]. As an information support system, management accounting is a general, objective and transparent information platform for refined value driver factor analysis and decision-making. The information support function is to support the managers at all levels within the organization to identify and determine the value drivers. The information in enterprises can support the enterprise to make relevant decisions and maintain daily operation services, thus reducing the product defect rate and improving the product innovation; by providing management accounting information, it can improve the service quality and customer satisfaction, obtain new customers, and increase market share and customer loyalty. The information provided by the management accounting system can improve the ability of employees to make decisions, so that employees can achieve the goals of the

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* Corresponding: Jingtao Wu (344970468@qq.com)

organization [2].

2. The Real Dilemma of Modern Management Accounting

(1) Management accounting awareness is not strong enough

Some enterprises do not have a comprehensive and specific understanding of management accounting, lack the awareness of management accounting, do not realize the important value of management accounting to the development of enterprises, and do not promote the application of management accounting in enterprise financial management. Specifically, some enterprise managers pay attention to the business, despise the financial situation. The application of management accounting not only needs the financial personnel to take the initiative, but also needs the active cooperation of grass-roots workers. However, some grass-roots workers in enterprises think that management accounting has nothing to do with their own work practice, and fail to actively cooperate.

(2) Institutional construction needs to be strengthened

The application of management accounting in enterprise financial management means that the content, process and specific standards of financial management will change to a certain extent. Enterprises should adjust the financial management system according to this change, so as to ensure the orderly development of the next financial management work. But some enterprises in the aspect of system construction, not according to the changes of financial management update system content, lead to financial personnel in the process of application management accounting is still working according to the original system, easy to cause the system content conflict with the actual work, not only hinder the application of management accounting, and may bring financial risk to the enterprise.

(3) The financial team construction is not in place

The application of management accounting puts forward higher requirements for the comprehensive level of enterprise financial personnel, but combined with the actual situation of some enterprises, the internal financial personnel of enterprises do not have a deep understanding of management accounting, and do not form a correct understanding of the application of management accounting. At the same time, some knowledge structure of financial personnel aging, failed to timely understand the cutting-edge financial knowledge, which also has a certain obstacle to the application of management accounting. The application of management accounting means that the accounting of enterprises and management practice are closely linked, which requires financial personnel not only to master financial knowledge, but also to understand the business development and management status of enterprises. However, some financial personnel of enterprises have obvious shortcomings in this aspect.

(4) Accounting information construction is not in place

On the one hand, there are still relatively obvious information barriers in some enterprises, which cannot guarantee the comprehensiveness and timeliness of accounting information. On the other hand, after collecting accounting information, enterprises cannot efficiently process accounting information, resulting in the data value of accounting information has not been fully mined. In addition, some enterprises ignore the information security problems in the process of applying management accounting, laying hidden dangers for the follow-up work.

(5) Supervision and control need to be strengthened

Supervision and control is an important link in the application process of management accounting, which is generally realized through the form of internal audit. However, in some enterprises, the audit work is often managed by the financial department, which leads to the loss of independence of internal audit and unable to form effective supervision over the application of management accounting.

3. Enterprise Organization and Social and Economic Development of the Modern Management Accounting to Put Forward the New Requirements

(1) The various forms of enterprise organization have put forward new requirements for modern management accounting

The diversity of enterprise organization forms has put forward many new requirements for modern management accounting. In order to adapt to these requirements, enterprises need to constantly strengthen the work of innovation of management accounting, improve the internal control system, improve the scientific and accuracy of financial decision, promote the development of information and intelligence, and pay attention to talent training and team building and other aspects.

A. Management accounting needs to adapt to the needs of different organizational forms

Different enterprise organizational forms have different characteristics and needs in the management. Modern management accounting needs to design corresponding financial management schemes according to the characteristics of different organizational forms to meet the personalized needs of enterprises. For example, for sole proprietorship and partnerships, management accounting may pay more attention to the financial reports and profit distribution of owners or partners, while for corporate enterprises, there may be more emphasis on the protection of shareholders' rights and interests and the improvement of corporate governance structure.

B. Strengthen internal control and risk management

With the diversification of enterprise organization forms, the internal control and risk management of enterprises have also become more complex. Modern management accounting needs to establish a set of perfect internal control system to ensure the authenticity and integrity of enterprise financial information, and strengthen the identification, assessment and control of all kinds of risks. This requires management accounting personnel not only to have solid professional accounting knowledge, but also familiar with the business process and risk management methods of enterprises.

C. Improve the scientificity and accuracy of financial decisions

The diversity of enterprise organization forms also means that enterprises need to be more scientific and accurate in their business decisions. Modern management accounting needs to provide comprehensive and accurate financial information to provide strong support for the strategic decision-making and daily operation of enterprises. This requires management accounting personnel to skillfully use various financial analysis tools and models, conduct in-depth analysis of the financial situation and operating results of the enterprise, and provide valuable decision-making suggestions for the management.

D. Promote the development of informatization and intelligence

With the rapid development of information technology, the diversification of enterprise organization forms also promotes the development of information and intelligence of management accounting. Modern management accounting needs to make full use of modern information technology means, such as big data, cloud computing, artificial intelligence, etc., to improve the efficiency and effect of financial management. Through the establishment of financial sharing service center, the implementation of intelligent financial analysis and other measures, enterprises can better realize the deep integration of finance and business, and improve the overall operation level.

E. Pay attention to talent training and team building

The diversity of enterprise organization forms puts forward higher requirements for management accounting personnel. In order to adapt to this change, enterprises need to strengthen the training of management accounting talents and team building. Improve the professional quality and comprehensive ability of management accounting personnel by organizing training and introducing high-end talents, and establish a sound incentive mechanism and career development channel to stimulate the enthusiasm and creativity of management accounting personnel.

(2) The change of the communication mode between the enterprise organization and other organizations puts forward new requirements for modern management accounting

The change of the communication mode between enterprise organizations and other organizations has put forward new requirements for modern management accounting, such as enhancing the transparency and comparability of financial information, strengthening risk management and internal control, improving decision support ability, adapting to diversified cooperation modes and strengthening the construction of information and intelligence. In order to meet these requirements, enterprises need to continuously strengthen the innovation and development of management accounting, in order to adapt to the changing market environment and business

needs.

A. Enhance the transparency and comparability of financial information

With the increasingly frequent and complex communication of enterprise organizations with other organizations, the transparency and comparability of financial information has become particularly important. Modern management accounting needs to ensure that the financial information provided by enterprises can accurately reflect its operating conditions, financial results and cash flow, and can make horizontal and vertical comparisons with other organizations. This requires management accounting to follow generally accepted accounting standards and regulations in preparing the financial statements to ensure that the information is true, complete and reliable.

B. Strengthen risk management and internal control

In the process of communicating with other organizations, enterprises will inevitably face various risks and uncertainties. Modern management accounting needs to strengthen the identification, assessment and control of these risks to ensure that enterprises can operate steadily in a complex and changeable external environment. This requires management accounting to establish a sound risk management mechanism and internal control system, conduct a comprehensive and systematic monitoring and evaluation of the activities of the enterprise, and timely find and correct potential problems and risks.

C. Improve the decision-making support ability

The purpose of communication between enterprise organizations and other organizations is often to realize resource sharing, complementary advantages and mutual benefit. Modern management accounting needs to provide strong support for enterprise decision-making and help enterprises make wise choices among many cooperation opportunities. This requires management accounting to use advanced analytical tools and models to conduct in-depth analysis of the financial situation, operating results and market environment, and provide valuable decision-making suggestions for the management.

D. Adapt to diversified cooperation modes

With the diversification of communication modes between enterprise organizations and other organizations, such as the rise of B2O (Business-to-Organization) business interaction mode, modern management accounting needs to adapt to this change and provide flexible and diverse financial management services for enterprises. For example, in the B2O model, enterprises need to establish close partnerships with multiple organizations to carry out projects or businesses together. Management accounting needs to be able to deal with this complex partnership to ensure the accurate transmission of financial information and the reasonable allocation of funds.

E. Strengthen information technology and intelligent construction

The change of the communication mode between enterprise organizations and other organizations also promotes the application of informatization and intelligence in management accounting. Modern management accounting needs to make full use of modern information technology means, such as big data, cloud computing, artificial intelligence, etc., to improve the efficiency and effect of financial management. Through the establishment of financial sharing service center, the implementation of intelligent financial analysis and other measures, enterprises can better realize the deep integration of finance and business, and improve the overall operation level.

4. Modern Management Accounting Enables the Path of Enterprise Organization and Social and Economic Development

(1) Optimize the organizational process

Management accounting is the integration of management and accounting. The function of accounting is to measure, and management is an activity involving everyone in the organization. Management accounting optimizes the organization's process and improves its efficiency through full participation and scientific measurement.

A. Improve the efficiency of enterprise internal management

Management accounting through the introduction of standardized processes, such as budget management, cost control, performance evaluation, etc., so that the work of various departments within the enterprise is more

standardized and orderly. This not only reduces unnecessary communication and coordination costs, but also improves work efficiency.

Management accounting emphasizes the fine analysis and management of data. Through the in-depth mining of business data, enterprises can more accurately grasp the market dynamics and customer needs, so as to make more scientific decisions. This fine management helps enterprises to optimize resource allocation and improve the overall operational efficiency.

B. Strengthen enterprise risk prevention and control capabilities

Through the establishment of a sound risk assessment system, management accounting conducts quantitative and qualitative analysis of all kinds of risks faced by enterprises, timely early warning and formulate corresponding countermeasures. This helps enterprises to reduce operational risks and maintain sound operations.

In the process of optimizing the organizational process, management accounting pays attention to strengthening internal control to ensure the legal compliance of various economic activities of enterprises. Through the establishment of a sound internal control system, enterprises can effectively prevent fraud and fraud, and ensure the safety of assets.

C. Promote the realization of corporate strategic goals

Management accounting provides information support on financial status, operating results and cash flow by participating in the formulation and implementation process of enterprise strategic planning. This helps enterprises to better grasp the market opportunities and formulate strategic goals in line with their own actual situation.

Management accounting through the establishment of a scientific performance evaluation system, the performance of each department of the enterprise objective, fair evaluation. This helps to stimulate the enthusiasm and creativity of employees, and promote the realization of corporate strategic goals.

D. Promoting economic and social development

Management accounting promotes the rational allocation and utilization of enterprise resources by optimizing the organizational process. This helps to improve the efficiency of the resource use of the whole society, and promote the sustainable development of the economy and society.

The data and information provided by management accounting can also provide strong support for government policy making. The government can, in accordance with the information provided by the management accounting, formulate macroeconomic policies more in line with the law of the market to promote the stable development of the economy and society.

(2) Cost reduction and cost-increase efficiency

Reducing costs and increasing efficiency is an eternal topic. Modern management accounting has played an important role in enabling enterprises to organize and promote economic and social development by optimizing the organizational process. Here are the details of the process:

A. Introduce advanced management methods and tools

By introducing advanced management methods and tools, such as comprehensive budget management, operation cost method, balanced scorecard, etc., management accounting can comb and optimize the internal management process of enterprises, reduce unnecessary links and redundancy, so as to improve operational efficiency. Through fine cost accounting and control, management accounting helps enterprises to identify the potential of cost saving, optimize the cost structure, reduce unnecessary expenses, and improve the overall profitability.

B. Strengthen internal control

In the process of optimizing the organizational process, management accounting pays attention to strengthening the construction of internal control mechanism to ensure the compliance and safety of economic activities of enterprises. Through the establishment of a sound internal control system, management accounting helps enterprises to prevent and defuse potential risks, to ensure the stable operation of enterprises.

C. Promote scientific decision-making

Management accounting provides strong decision support for the management by providing accurate and

timely financial information and analysis reports. According to these information, the management can more scientifically formulate enterprise strategies, plan business activities, and evaluate the effect of projects, so as to improve the scientificity and accuracy of decision-making.

D. Promote the integration of business and finance

Management accounting promotes the integration of business and finance by optimizing the organizational process. The financial department is no longer just a "bookkeeping" department, but deep into each business link of the enterprise, to provide targeted financial advice and services. This integration helps enterprises to better grasp the market dynamics and customer demand, and improve the market competitiveness.

(3) Enhance the social value of the organization

A. Promote the optimal allocation of resources

Management accounting improves the use efficiency of using resources by optimizing the process of enterprise organization. As the micro subject of social economy, the improvement of the resource use efficiency of enterprises helps to promote the optimal allocation and sustainable development of resources of the whole society.

B. Enhance corporate social responsibility

Management accounting pays attention to the social responsibility and sustainable development of enterprises. By providing financial information and advice related to environmental protection, social responsibility and other aspects, management accounting helps enterprises to enhance their social responsibility, and promotes enterprises to achieve economic benefits, but also pay attention to the improvement of social benefits and environmental benefits.

5. Future Prospects of Modern Management Accounting

With the progress of enterprise organization and social economy, the development potential of modern management accounting still needs to be further explored. Zhang Chao put forward that the combination of management accounting informatization and advanced information technology will become a research trend [3]. Similarly, Ma Yizhou pointed out that with the strong support of legislation and education work, the continuous emergence of management accounting talents, theoretical research is constantly enriched and in-depth, and the potential of management accounting in the future will be further reflected, and it can be better applied to enterprises [4–7].

Modern management accounting has a significant role in promoting enterprise organization and social and economic development. Although there are some challenges, such as lack of management accounting consciousness, system and the construction of talent, as well as the shortage of informatization and supervision and control, but through the construction of modern management accounting system with Chinese characteristics, strengthening the informatization construction and personnel training, management accounting potential will be further mining and play, to more effectively support the sustainable development of enterprises and the comprehensive progress of social economy.

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References

1 Bin W, Chen G. On the Integration System of Management Accounting Tools. *Accounting Research* 2004; **4**: 59–64.

2 Horngren TC, Foster G, Datar MS. Cost Accounting: A Managerial Emphasis. *Issues in Accounting Education* 2000; **25**(**4**): 789–790.

3 Chao Z. Summary of Domestic Research on Management Accounting Informatization. *Accounting Monthly* 2015; **28**: 101–105.

4 Yizhou M. Discussion on the Development Trend of Management Accounting. *Economic and Social Development* 2014; **12**(**2**): 20–23.

5 Xiujuan S, Peng Z. Research on Management Accounting Tools, Management Accounting Functions and Value Creation—Based on the Perspective of Enterprise Value Chain. *Friends of Accounting* 2022; **13**: 37–43.

6 Qinhui C. Research on the Application Path of Management Accounting in Enterprise Financial Management. *China Agricultural Accounting* 2023; **33**(**20**): 12–14.

7 Yuzhuo C, Min W. Summary of Domestic Research on Management Accounting Development. *Modern Business Industry* 2019; **40**(**06**): 112–113.

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Article

Hurdles in the Adoption of Digital Technologies in the Agriculture Sector of Bihar

Santosh Kumar * and Md. Alamgir

Department of Applied Economics and Commerce, Patna University, Patna, Bihar 800005, India; mohammadalamgir654@gmail.com

Abstract: Purpose Since digitization has significant potential to benefit both farmers and consumers, there is currently a strong drive for its wider adoption in the agricultural sector. However, bringing technological advancements to rural areas presents a number of difficulties. Bihar's rural areas are going through a digital transformation. The primary impediments to the digitalization of the agriculture sector in Bihar are examined in this study. Research Design/ methodology There are three sources for the information used in the analysis. One from literature reviews, the second from official government websites/reports, and the third as responses of farmers towards the constraints of using Digital technologies in the agriculture sector of Bihar. It also incorporates the researcher's personal observations and measurements of events. On the basis of information collected from the 210 respondent farmers, we highlighted the main constraints of digitalization that farmers are facing in the agriculture sector in Bihar. Findings Digitalization in the agricultural sector decreases costs, boosts productivity and quality, increases prices, minimizes risks, and nurtures a more sustainable ecology. The finding of the study indicates that Hesitation in adopting digital technologies due to small and fragmented land, Lack of training and motivation to capitalize on agriculture, High cost, insufficient power supply, poor internet connection in a rural area, lack of skill and awareness, are main lack of subsidies are main hurdles in an adaptation of digitalization in the agriculture sector of Bihar. Suggestion: Effective Farmers' interest in Digitalization and financial support in terms of subsidy may aid them in startups also. A new level of development for the farm sector has been enabled by the combination of technology and financial support. The findings of the study will be helpful for policymakers to evaluate the scheme. Value/ Novelty: The study provides a fresh theoretical viewpoint on the digitalization of rural and agricultural growth, which has an impact on the entitlements of millions of farmers nationwide.

Keywords: digital technologies; smart farming; agriculture 4.0; agriculture 5.0; subsidy; sustainability

1. Introduction

India is one of the fastest-growing economies in the world and is one of the major producers of food worldwide. In India, agriculture is the key sector for guaranteeing food and nutritional security, sustainable development, and eradicating poverty. The main problems that India's agrarian economy faces today, however, are food security, population growth, monsoon whims, and the illiterate nature of its farmers [1]. The report by [2] estimate that, in order to feed India's anticipated 1.8 billion population by 2050, food production will need

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* Corresponding: Santosh Kumar (krsant1994@gmail.com)

to roughly triple. Therefore, Digitization of the agriculture sector is critical to achieving this level of success. The government takes steps under the Digital Agriculture Mission for projects based on new technologies like IoT**,** artificial intelligence, Machine learning, remote sensing, drones and robots, and so on, in terms of improving farmer production, earnings, and livelihoods. On the basis of the digital revolution, India's position will be moved from the 'Green Revolution' to the 'Evergreen Revolution' [3]. Agricultural value chains are being transformed and operations are being modernized by digital technologies and services because digital technologies have been a big potential booster for the field of agriculture [4]. This digital revolution in agriculture is very promising and the agriculture industry will be able to go to the next level of farm production and profitability. [5, 6], estimated that, with advanced techniques, the IoT has the ability to boost farm productivity and profitability by 2050. Today, however, Agriculture 4.0 is based on Smart Farming principles, with farmers adopting systems that produce data on their farms, which will be analyzed in order to help farmers make the right operational and strategic decisions. Traditionally, farmers would visit the fields to assess the condition of their crops and take decisions based on their knowledge. The authors [7] claimed that the application of ICT in agriculture is referred to as "smart farming." ICT-based data collection and analysis support effective agricultural activities. ICT also makes farming practices more precise and controlled, lowering costs and having a smaller negative impact on the environment while simultaneously improving production. [8] also said that Smart farming has the potential to also improve work safety, contributing to the sustainability of agriculture. Numerous attempts have been made to improve the efficiency of agricultural production and the full value chain in the age of digitization, but compared to other sectors, adoption of technology is still quite low [9] Let's compare an average Indian farm to those in the US, Australia, and Europe in order to better comprehend the difficulties posed by digital agriculture in India. The average farm size in the US is 17, 920 Hectares, compared to 4331.21 Hectares in Australia, 16.122 Hectares in Europe, and 1.0823 Hectares in India. The implementation of Digital Agriculture in India could be severely impacted by this gap. If we want Digital Agriculture to be scalable and available to the majority of Indian farms, it must be tailored to be suitable for a typical Indian small farm [10]

In India, where food was extremely scarce, the first Green Revolution was implemented to guarantee food security. Eastern India will lead the second Green Revolution, which will use technology breakthroughs to create sustainable agriculture because that region's potential has not yet been actualized. Eastern India is the area of focus because it is where the Second Green Revolution must originate. Bihar is a prominent agrarian state in eastern India [11]. In Bihar, agriculture provides a living for more than two-thirds of the population. In an agricultural state like Bihar, it is especially important to focus efforts on the regions where the majority of the people earn their living. There must be action made to improve the income and standard of living of Bihar's farmers because they make an exceedingly inadequate average income. The agricultural revolution in Bihar has been hampered by farmers' lack of access to agricultural finance and digital transformation. Especially the rural parts of Bihar are undergoing a digital transformation. The first obstacle towards the full implementation of smart farming in rural areas is the lack of connectivity, i. e., digital divide. This study examines the serious constraints of the digitalization of the agriculture sector of Bihar. It also considers the factors that influence how people use digital technologies and services.

2. Problem Statement

There is widespread agreement that Indian agriculture has to be digitalized, and efforts are being made to digitize the existing value chain. Agriculture in the modern world is already heavily reliant on digital technology. Through the power of contemporary technology, ICTs assist in empowering the rural population by granting better access to technology, natural resources, enhanced agricultural methods, efficient production tactics, market access, and much more. [12] Digital Green and JEEViKA or government-led Bihar Rural Livelihoods Project have been partners for the last three years, using an ICT-enabled collective learning approach to promote best practices among rural community groups. The level of penetration of digital technologies in agriculture in Bihar as compared to the other states is relatively small and the introduction of advanced digital services is slow. If hurdles in adaptation of digitalization in agriculture sector would be studied,

it will provide various bottlenecks that hindered the growth of economy and agriculture sector. Moreover, if the problems or reasons of hesitation will be found out, then appropriate suggestions for the problems would be provided, which would be helpful for the policy-makers, government, and scholars.

3. Review of Literature

Some research has been done in the field of digitalization and modernization of the agriculture sector. Some of the important works are mentioned here. The authors [13] explained that a variety of factors affect the adoption of technology, and that both the impact and the degree of that adoption fluctuate widely on the farmer and the area.They also said that any agricultural technology or strategy related to it must take into account small and marginal farmers as its most important component. Similar to this, the authors [14] highlighted the political, social, and economic concerns influencing the adoption of digital technology in the agriculture sector. They argued that implementing digital technology presents major difficulties and constraints for small-scale farmers. The study's conclusions demonstrate the importance of the state's institutional support and role in governance in fostering cross-sector cooperation and engagement. The authors [15] highlight the impact of digitalization on the Indian economy in several sectors. Similarly, a study where the author noted that Digitalization of agriculture is key to the rapid evolution from the inefficient and even detrimental farming practices of the current scenario [11]. He conclude that the success of digital agriculture in India depends on the availability of low-cost technology, user-friendly portable equipment, pay-per-use rental models, legislative support, and the ability to leverage farmer collectives' strengths. In the next, [16] describe the main opportunities and difficulties brought about by digitalization processes in the agri-food sector. He said that the food system and farming issues might both benefit from digitization. Similarly, [17] explored the challenges and opportunities associated to the adoption of precision farming in India with the use of in-depth interviews with ten farmers from Hyderabad. In another paper the authors [18] stated that, especially in emerging nations, the digital divide in rural areas is a significant social problem. The study shows that the mobile platform is viewed as a cutting-edge and efficient instrument to close the digital divide and aid rural areas in achieving social and economic empowerment based on a case study of one mobile platform in rural China. Again in a study, the author [19] outlined organizational constraints and structural changes that influence the digitization process's favorable and negative effects. In one of the study, the authors [20] claimed that the biggest barrier to India's agricultural potential realization is the transfer of technology. They concentrated on the degree of contemporary technology adoption, accessibility and quality, access to extension institutions, and challenges faced by extension authorities in the transfer of technology. Further the authors [21] have been examined the problems affecting the agricultural sector in Bihar state, India, along with potential strategic interventions to adopt a multi-pronged development plan and make the greatest use of the resources at hand. Additionally, it discusses difficulties unique to the location and makes suggestions for solutions. The authors [22] presents a concise framework for outlining the key advantages of emerging information and communications technologies in his paper. The report examines current research on related technological effects in developing nations' rural sectors. Similarly a study [23] used secondary data to evaluate how digitization has affected Indian farmers. They arrive to the conclusion that digitalization may greatly boost farmers' revenue and that it has helped the agriculture industry grow and advance the economy. In the next the authors [24] aims to provide some insights on the effects of digitalization on agriculture and rural areas in terms of the digital, economic, and environmental aspects. The authors of this paper aim to identify and discuss the potential consequences of digital technology on agriculture and rural areas. They also highlight some negative impacts of digitalization i.e., Farmers may also become reliant on digital service providers, resulting in a loss of autonomy.

The researches done earlier were unable to depict some of the new and hidden hurdles in adaptation of digitals tools in agriculture sector of Bihar. Hence, this aspect has been covered in this study. Apart from that most of the previous studies are related to other states rather than Bihar.

4. Research Design/Methodology

Materials used in the analysis come from three sources- one from literature reviews, second from official

government websites/reports and third as responses of farmers towards Digital technologies in agriculture sector of Bihar. A questionnaire that has been written in both Hindi and English was used to collect the primary data. The questionnaire includes the land holding, age, farming experience, and opinion of the farmers regarding the various problems of digitalization of the agriculture sector of Bihar on a Likert scale of 1 to7. On the basis of responses collected from the 210 respondent farmers of Khagaria district of Bihar, we highlight the main constraints of digitalization which farmers are facing in the agriculture sector in Bihar. It also incorporates the researcher's personal observations and measurements of events. For the purpose of finding the mean rank of various constraints of digitalization in agriculture sector, Kendall's Coefficient of Concordance which is the non-parametric version of ANOVA has been applied. The scope of the research is limited to the agricultural sector of Bihar only. The study's limitations are addressed, and potential areas for future research are recommended.

4.1. Analysis, Findings and Discussion of Primary Data

4.2. How Digitalization Took footprints of It in Agriculture Sector?

By 2050, the globe will need to generate at least 70% more food. As a result of the widespread use and depletion of our natural resources and the dwindling size of our agricultural lands, the need to increase farm productivity raises severe ethical questions. Despite the difficulties associated with the environment, agriculture must develop to keep up with the need for food since the world's population is expanding at a very rapid rate. Future generations will utilize smart agriculture and other technology in the years to come. Common terms for the applications of IoT solutions in agriculture include smart agriculture and smart farming. Through the Internet of Things (IoT), smart farming and precision farming are enabling the agriculture sector to minimize costs, eliminate waste, improve operational efficiency, and increase crop quality. In modern technology era, drones for agriculture are one of the popular applications. Crop health assessments, crop spraying, planting, and many more operations involve the usage of aerial and ground drones. Drone technology has renewed and changed the whole agriculture sector with the appropriate planning and strategy based on real-time data. The importance of digitalization in Indian agriculture is widely recognized, and efforts are underway to digitalize the current value chain. To encourage farmers to utilize technology, the Ministry of Agriculture and Farmers Welfare has developed many important digital applications. Digital agriculture refers to the use of data and technology to inform agricultural decisions and processes, and it has the potential to make the entire agricultural sector more effective, transparent, profitable, and ethical. Using modern technologies, rural India can undergo transformation. Farmers can gain new perspectives and receive improved guidance from sensors in the field, automated farm machinery, and data from satellites and drones. A survey has been conducted within Khagaria District in Bihar with the help of questionnaire method. The Khagaria district is known as "languishing land of seven rivers" and it faces floods almost every year. With the use of tables and figures, the findings and analyses are described below (as shown in Table 1).

Table 1. Number of respondent farmers on the basis of operational land holdings.

Types of Farmers on the Basis of Operational Holdings	Numbers of Respondents Farmers
Marginal farmers (Below 1 ha)	97
Small Farmers (1 ha to 2 ha)	63
Semi-medium (2 ha to 4 ha)	31
Medium (4 ha to 10 ha)	14
Large (more than 10 ha)	5
Grand Total	210

Source: Authors' Computation using excel.

The above table mentioned total numbers and types of respondent farmers on the basis of operational land holding.

4.3. Hurdles of digitalization in Agriculture Sector of Bihar

Transformation of Agriculture sector and rural area can be done with the help of digital technologies. There are various constraints of digitalization of agriculture sector in Bihar. Some major constraints are covered in this study. The views of the farmers were taken through the rating scale on various problems in order to determine the major Constraints of digitalization in agriculture sector. Table 2 shows the degree of agreeability of different category of farmers regarding the hurdles of digitalization in agriculture sector of Bihar.

Table 2. Degree of agreeability of farmers in bihar on various hurdles of digitalization in the agriculture sectors.

Hurdles of Digitalization in Agriculture Sector of Bihar	Degree of Agreeability							
	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	GT
Hesitation in adopting digital technologies due to small and fragmented land	5	42	20	32	14	44	53	210
Lack of training and motivation to capitalization in agriculture	24	24	35	38	22	30	37	210
There are in-sufficient power supply	12	33	23	30	19	50	43	210
State inefficiencies in distributing agriculture subsidies	16	31	22	40	20	40	41	210
Internet connection is poor or slow in your area.	18	25	21	38	24	40	44	210
Lack of skill in handling ICT tools	16	25	22	48	22	39	38	210
Lack of awareness of benefit of ICT and digitals tools	17	25	17	35	30	46	40	210
Language problems	24	24	35	38	22	30	37	210
Poor understanding of technologies (lack of knowledge)	9	32	23	31	23	56	35	210
High cost of digital tools (set up and running cost)	14	43	21	35	22	45	30	210
Lack of awareness towards banking facilities	6	33	17	48	16	44	46	210

Authors own computation using SPSS 25

The above table reveals the opinion of different types of farmers regarding the agreeability of various

hurdles of using Digital technologies in farm activities on a scale of 1 to 7. In case of hesitation in adopting digital technologies due to small and fragmented land, 143 (68%) of farmers have rated 4 or more on the scale of 7 which reflects their acceptance towards that. As per results of Agriculture census 2015–16, Bihar has one of the lowest average size of land holding in hectare (0.39) among all the state. In case of Lack of training and motivation to capitalization in agriculture 127 (60%) of farmers have rated 5 or more on the scale which indicate that there are lack of motivation factors for capitalization in agriculture. Similarly, in case of remaining hurdles of digitalization, most of the farmers have rated 5 or more on the rating scale of 1 to 7Basic literacy and numeracy skills, as well as specialized technical knowledge and abilities, are necessary for using digital technology. The major obstacle for farmers in rural areas is a lack of understanding of technology. People lacking these skills may be excluded in societies that are becoming more digitally oriented. In emerging nations, rural areas may have less access to information and education than urban ones [25] Furthermore, limited access to mechanization equipment and usual natural disasters like as floods droughts, excessive and untimely monsoon rains have restricted the implementation of digital agriculture solutions [26].

5. Hypothesis Testing

H0: All the constraints covered under this study are equally act as a hurdles in digitalization of agriculture sector in Khagaria District.

The data related to the constraints / hurdles of digitalization in agriculture sector of in Khagaria District are gathered in Likert Scale at 7 points rating scale. One way ANOVA with Repeated Measures can be used to determine whether all the factors discussed in this study are equally accountable as hurdles for the digitalization in agriculture sector of Bihar. The 07 Point Likert Scale was used to quantify the data, despite the fact that they are qualitative in nature. Therefore, a parametric test can only be used if the data is normally distributed. Before employing ANOVA with Repeated Measures, it is necessary to ensure that the data collected about the evaluation of hurdles to the digitalization of the farm industry are regularly distributed (as shown in Table 3).

Table 3. Tests of Normality.

Constraints of Digitalization of Agriculture	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
Hesitation in adopting digital technologies due to small and fragmented land	0.195	210	0.000	0.897	210	0.000
Lack of training and motivation to capitalization in agriculture	0.208	210	0.000	0.894	210	0.000
There are in-sufficient power supply.	0.170	210	0.000	0.919	210	0.000
State inefficiencies in distributing agriculture subsidies	0.161	210	0.000	0.919	210	0.000
Internet connection is poor or slow in your area.	0.178	210	0.000	0.905	210	0.000
lack of skill in handling ICT tools	0.217	210	0.000	0.893	210	0.000
Lack of awareness of benefit of ICT and digitals tools	0.141	210	0.000	0.919	210	0.000
Language problems	0.171	210	0.000	0.910	210	0.000
Poor understanding of technologies (lack of knowledge)	0.173	210	0.000	0.906	210	0.000

Cont.

Constraints of Digitalization of Agriculture	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
High cost of digital tools (set up and running cost)	0.210	210	0.000	0.900	210	0.000
Lack of awareness towards banking facilities	0.174	210	0.000	0.909	210	0.000

a. Lilliefors Significance Correction

Source: Authors' Computation using SPSS 25.

Based on the aforementioned Kolmogorov-Smirnov and Shapiro-Wilk test results, it can be concluded that the study's data on the obstacles of agricultural digitalization is not normally distributed. A parametric test like an ANOVA with Repeated Measures cannot be used as a result. Here, the non-parametric test of ANOVA with Repeated Measures, known as the Kendall's Coefficient of Concordance, has been used to examine the mean rank of hurdles of digitalization in the Khagaria district of Bihar (as shown in Tables 4 and 5).

Table 4. Mean rank of hurdles of digitalization of agriculture sector.

Hurdles of Digitalization in Agriculture	Mean Rank	Rank
Hesitation in adopting digital technologies due to small and fragmented land	6.46	I
Lack of training and motivation to capitalization in agriculture	6.37	II
There are in-sufficient power supply	5.61	IX
State inefficiencies in distributing agriculture subsidies	5.90	VIII
Internet connection is poor or slow in your area.	6.23	IV
Lack of skill in handling ICT tools	6.17	V
Lack of awareness of benefit of ICT and digitals tools	5.40	XI
Language problems	5.47	X
Poor understanding of technologies (lack of knowledge)	6.07	VI
High cost of digital tools (set up and running cost)	6.36	III
Lack of awareness towards banking facilities	5.97	VII

Source: Authors' Computation using SPSS 25.

Table 5. Test Statistics Kendall's Coefficient of Concordance.

Test Statistics	
N	210
Kendall's Wa	0.015
Chi-Square	31.881
Df	10
Asymp. Sig.	0.000

a. Kendall's Coefficient of Concordance

Source: Authors' Computation using SPSS 25.

Applying Kendall's Coefficient of Concordance reveals that the Significance value is less than 0.05, indicating that not all causes are equally to blame for the difficulties in digitalization in Bihar's agricultural

sector.

6. Conclusions and Suggestions

In the upcoming years, farming and food production will change significantly as a result of the digitalization of agriculture [27–29]. The above observations and results of hypothesis testing depict that the major hurdles of digitalization in agriculture sector is small and fragmented land holding of famers followed by Lack of training and motivation to capitalization in agriculture followed by High cost of digital tools (set up and running cost). Many of the farmers hesitate to move on digital technologies because without having the power supply and proper internet facilities digital transformation of farm activities are no be possible. Apart from that some of the of the respondents farmers feel that the Lack of awareness and skill to use of ICT and digitals tools State inefficiencies in distributing agriculture subsidies Lack of awareness towards banking facilities are also the restraints in using digital technologies in agriculture sector of Bihar. Affordability of technology, ease of use and operation, ease of system maintenance, internet accessibility, and supportive regulatory frameworks are crucial elements that will decide the success of digital agriculture in India Similarly, The Dalwai committee report estimates that the average farmer's income in India is Rupees 7, 797, 625 (about $1000 USD) per year, so lowering the cost of technology will make it more accessible and affordable for smaller farmers. For the typical Indian farmer, it is essential that the technology be appealing to farmers and affordable through subsidies. Natural disasters are common, particularly floods in north Bihar and drought in south Bihar. By utilizing the right crop technologies and providing crop insurance to all farmers, the risk of natural catastrophes will be reduced. Further, the government must frequently organize awareness, training, and motivational programs and must also monitor those programs. Our extension services and agriculture related academic institutions should also change their focus to digital agriculture because they are the people who are interacting with farmers for introducing anything new.

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References

1 Myklevy M, Doherty P, Makower J. The New Grand Strategy: Restoring America's Prosperity, secutiry, and Sustainability in the 21st Century. In The New Grand Strategy; St. Martin's Press: NewYork,NY,USA, 2016. Available online: https://ndupress. ndu. edu/Portals/68/Documents/jfq/jfq-85/jfq-85_87_Russ. pdf

(accessed on 27 October 2023).

2 Bhavani rv, Swaminathan M. Food Production and Availability – Essential Prerequisites for Sustainable Food Security. *The Indian Journal of Medical Research* 2013; **138**(**3**): 383–384.

3 Swaminathan M, Kesavan PC. From Green Revolution to Evergreen Revolution: Pathways and Terminologies. *Current Science* 2006; **91**: 145–146.

4 Tzounis A, Katsoulas, N, Bartzanas, T, Kittas, C. Internet of Things in Agriculture, Recent Advances and Future Challanges. *Biosystems Engineering* 2017; **164**: 31–48. DOI: 10.1016/j.biosystemseng.2017.09.007.

5 Sarni W, Mariani J, Kaji J. From Dirt to Data: The Second Green Revolution and the Internet of Things. *Deloitte Reviews* 2019. Available online: https://www2.deloitte.com/content/dam/insights/us/articles/second-green-revolution-and-internet-of-things/DR18_From_Dirt_to_Data.pdf (accessed on 27 October 2023).

6 S. Himesh EV. Digital Revolution and Big Data: A New Revolution in Agriculture. *CABI Reviews* 2018; **2018**: 1–7. DOI: 10.1079/PAVSNNR201813021.

7 Walter A, Finger R, Huber R, Buchmann, N. Opinion: Smart Farming is the Keys to Developing Sustainable Agriculture. Proceedings of the National Academy of Sciences of the United States of America 2017; **114**: 6148–6150.

8 Tsifrovizatsiya. Digitalization is the Most Effective Way Toreduce Cost. Samyy Effektivnyy Put' k Snizheniyu Sebestoimosti. 2018. Available online: File:///F:/DIGITALIZATION% 20OF% 20AGRICULTURE% 20SECTOR/ICA% 20paper% 20last% 20date% 2025%20oct% 202022/BEST% 202. pdf (accessed on 27 October 2023).

9 Bacco M, Barsocchi P, Ferro E, Gotta A, Ruggeri M. The Digitisation of Agriculture: A Survey of Research Activities on smart farming. *Array* 2019; **3**: 100009. DOI: 10.1016/j.array.2019.100009.

10 Puranik V, Sharmila Ranjan A, Kumari A. Automation in Agriculture and IoT. *IEEE* 2019; **2019**: 1–6.DOI: 10.1109/IoT-SIU.2019.8777619.

11 Beriya A. Digital Agriculture: Challenges and Possibilities in India. *ICT India Working Paper*, No. 35. 2020. Available online: https://www. econstor. eu/bitstream/10419/249824/1/ICT-India-Working-Paper-35. pdf (accessed on 27 October 2023).

12 Sundaram P, Sarkar B, Jeet P, Patel S, Anurag A, Upadhyaya, A. Dynamics of Farm Power Sources and their Availability in Bihar. *Journal of AgriSearch* 2020; **7**: 128–131.

13 Deepali C. Digitalization of Agriculture in India: Pathway to Prosperity. *Agribusiness Development Planning and Management* 2021; **2021**: 21–34. https://doi.org/10.30954/NDP.agribusiness.2020.3.

14 Khandker V, Gandhi V. Agricultural Technologies for Marginal and Landless Farmers: The Case of Hybrid Rice Cultivation in India. *Agricultural Economics Research Review* 2021; **34**: 165–178. DOI: 10.5958/0974-0279.2021.00036.7.

15 Smidt HJ, Jokonya O. Factors Affecting Digital Technology Adoption by Small-Scale Farmers in Agriculture Value Chains (AVCs) in South Africa. *Information Technology for Development* 2022; **28**: 558–584. DOI: 10.1080/02681102.2021.1975256.

16 Badam D, Gochhait D. Digitalization and its Impact on Indian Economy. *European Journal of Molecular Clinical Medicine* 2020; **7**: 2131–2140.

17 Kosior K. Digital Transfromation in the Agri- Food Sector-Opportuninties and Challenges. *Roczniki* 2018; **20**: 103. DOI: 10.5604/01.3001.0011.8122.

18 Soma MK, Shaheen M, Aruna M, Zeba F. Precision Agriculture in India—Challenges Andopportunities. *International Review of Law and Economics* 2019; **16**: 223–246. DOI: 10.2139/ssrn.3363092.

19 Ye L, Yang H. From Digital Divide to Social Inclusion: A Tale of Mobile Platform Empowerment in Rural Areas. *Sustainability* 2020; **12**: 2424. DOI: 10.3390/su12062424.

20 Vial G. Understanding Digital Transformation: A Review and a Research Agenda. *Managing Digital Transformation* 2019; **28**: 118–144. DOI: 10.1016/j.jsis.2019.01.003.

21 Singh K, Sungh R, Kumar A. Adoption of Modern Agricultural Technologies in Bihar: A Farm Level Study. *Environment Ecology* 2014; **32**: 1342–1346.

22 Singh K, Singh R, Kumar A, Meena M, Shahi B. Agricultural Scenario and Strategies for Development: The

Case of Bihar. *MPRA Paper No*. 67133, Posted 5 07:12 UTC. 2015. Available online: https://mpra.ub.uni-muenchen.de/67133/ (accessed on 27 October 2023).

23 Deichmann U, Goyal A, Mishra D. Will Digital Technologies Transform Agriculture in Developing Countries? *Policy Research Working Paper*; No. 7669. 2016. Available online: https://openknowledge.worldbank. org/bitstream/handle/10986/24507/Will0digital0t0veloping0countries00. pdf? sequence= 1&isAllowed=y (accessed on 27 October 2023).

24 Gautam RS, Bhimavarapu VM, Rastogi S. Impact of Digitalization on the Farmers in India: Evidence using Panel Data Analysis. *International Journal of Management and Humanities* 2021; **6**: 5–12. DOI: 10.35940/ijmh.L1372.0851221.

25 Rolandi S, Brunori G, Bacco M, Scotti I. The Digitalization of Agriculture and Rural Areas: Towards a Taxonomy of the Impacts. *Sustainability* 2021; **13**: 5172. DOI: 10.3390/su13095172.

26 FAO. Youth and Agriculture Key Challenges and Concrete Solutions; FAO: Rome, Italy, 2014. Available online: https://www.fao.org/3/i3947e/i3947e.pdf (accessed on 27 October 2023).

27 Kumar S, Alamgir DM. Constraints of Farm Mechanization and Subsidies Distribution in the Agriculture Sector of Bihar. *MUDRA Journal of Finance and Accounting* 2022; **9**: 1–14. DOI: 10.17492/jpi.mudra.v9i2.92220.

28 Baryshnikova N, Altukhov P, Naidenova N, Shkryabina A. Ensuring Global Food Security: Transforming Approaches in the Context of Agriculture 5.0. *IOP Conference Series Earth and Environmental Science* 2022; **988**: 5. DOI: 10.1088/1755-1315/988/3/032024.

29 Kaila H, Trap F. Can the Internet improve agricultural production? *Evidence*. Agricultural Economics 2019; **50**: 675–691. onlineAvailable: Wileyonlinelibrary.com/journal/agec (accessed on 27 October 2023).

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Article

Artificial Intelligence Technology Development and Audit Innovation

Yang Han, Yiwei Deng * and Xiujuan Ran

Hubei Accounting Society Research Group, Hubei Huaren Zhiyuan Accounting Firm (General Partnership), Xiangyang 441005, China

Abstract: Artificial intelligence technology is an important element of stimulate economic vitality, but the artificial intelligence technology resources into the table may face the risk of confirmation and measurement standards to grasp, this poses the challenge to accounting, also challenge the audit, audit how innovation to cope with the development of artificial intelligence technology confirmation and measurement difficulties, practical and theoretical circles in some discussion. Based on the perspectives of audit objectives, audit importance, audit risk and audit procedure.

Keywords: artificial intelligence technology; confirmation; measurement; audit innovation

1. New Requirements for Audit Objectives under Artificial Intelligence Technology

In the era of artificial intelligence, audit is facing new challenges. There is no systematic study on how to determine the audit objectives under artificial intelligence technology. In the classical audit theory, the audit goal is divided into the direct goal and the ultimate goal, in which the direct goal is the direct output of the audit process, and the ultimate goal is the final result of the audit. Under the artificial intelligence technology, the direct goal and ultimate goal of audit will not change, and the artificial intelligence technology puts forward new requirements for the direct goal and ultimate goal of audit.

(1) New requirements of artificial intelligence technology for the direct objectives of audit

The view about what the direct output of audit under artificial intelligence involves legitimacy, responsibility, ethics, transparency, trustworthiness, science, fairness, security, risk and so on. The purpose of the audit is to examine the extent to which potential products comply with established programming standards in a practical environment, while the audit is expected to hold the public and private sectors accountable for the risks that their algorithmic systems may pose, reducing potential risks and improving technical ethics. Qualcomm proposed to introduce a risk assessment mechanism in the social risk review to strengthen the scientific nature and fairness of the review [1]. After the audit model came into being, Wang Yufeng proposed that government audit institutions should focus on four parties in the audit model algorithm: the compliance of the model algorithm, the security of the model algorithm, the risk of the model algorithm, and the transparency of the model algorithm [2]. Therefore, under the artificial intelligence technology, the direct goal of the audit is to improve the audit quality while using the artificial intelligence technology. The birth of artificial intelligence audit is a new type of audit to achieve the direct goal of audit under the technology of artificial intelligence

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* Corresponding: Yiwei Deng (406881492@qq.com)

technology.

(2) The new requirements of artificial intelligence technology for the ultimate goal of audit

Audit comes from the separation of ownership and management right, which aims to reduce the agency cost. Through the verification of the financial statements, profit forecast of the audited unit, internal control and economic responsibility performance. Under the artificial intelligence technology, the value, governance efficiency and purpose of audit can be better realized through algorithm audit. According to Zhang Yongzhong and Zhang Baoshan the system value of algorithm audit is reflected in the following three aspects: first, standardize and supervise algorithm power and maintain data justice; second, to prevent digital risk and deal with the dispersion of algorithm power; third, the control of algorithm alienation, balance the transparent value of algorithm, and the ultimate goal of algorithm audit [3–9]. However, at the present stage, the algorithm audit is still in its initial stage, and the theoretical framework of the systematic algorithm audit goal through the classical audit theory has not yet been formed. The embodiment of the algorithm audit's ultimate goal of reducing the agency cost in the future needs to be continuously improved with the development of technology.

2. New Requirements for the Importance of Artificial Intelligence Technology in the Audit

The importance of audit refers to the severity of the misstatement or underreporting, which will affect the decision of the user of the statement. The determination of the importance level includes two aspects: nature and quantity. After determining the importance level in the audit plan stage, the audit subject should adjust the importance level according to the audit development to reduce the audit risk. At present, the financial audit of enterprises is affected by the network environment, and the work content is becoming more and more complicated. Combined with the development trend of The Times, the use of artificial intelligence technology to carry out the enterprise financial audit work can improve the existing financial level of enterprises and ensure the effectiveness of the audit results.

(1) Improve the audit efficiency, so that the importance level is determined earlier

The effective application of artificial intelligence technology in enterprise financial audit can comprehensively improve the efficiency of data processing. In the financial audit work, the staff needs to analyze a large number of data information, transaction vouchers, contract terms, sales documents and other data closely related to the enterprise finance. In recent years, the enterprise financial audit process is more and more complex, in the process of data verification need to consume a lot of manpower and material resources, the effective application of artificial intelligence technology can ensure the accuracy of the data extraction and analysis process, directly through the artificial intelligence technology calculus to get the final audit results, simplify the auditors data collection and processing time. Artificial intelligence technology with expert analysis system, to verify financial data and data information work, compared with the previous financial statements, ensure the accuracy of financial information, improve the efficiency of enterprise financial audit, avoid repeating tedious work content, make the importance level of determine time earlier, reduce the importance of subsequent adjustment of audit procedures.

(2) Expand the scope of audit and adjust the level of importance

The effective application of artificial intelligence technology can promote the enterprise audit mode innovation and change, make the traditional sampling audit gradually to the overall audit, break the limitations of traditional audit work, artificial intelligence technology in the process of data analysis and acquisition, not affected by the environment and technology level, to conduct a comprehensive audit of comprehensive information. According to the financial management in the process of enterprise development to expand the scope of the audit, effectively prevent financial audit risk, artificial intelligence technology can extract the required data in the massive data, and comprehensive evaluation of data content, timely found the main factors affecting the audit results, clear audit risk source, by expanding the scope of the audit to reduce audit risk, avoid the numerical error in the traditional audit process, and can adjust the importance level.

(3) Real-time information sharing to make the determination of the importance level more scientific and reasonable

In the process of enterprise development, the establishment of artificial intelligence information platform

provides convenience for the development of enterprise financial audit work. Auditors do not need to collect data from various departments of the enterprise, but store the data information into the database of the unified information platform through network communication, so that they can obtain the data required for audit anytime and anywhere, simplify the intermediate process of enterprise audit, and comprehensively improve the audit effect. Effective application of cloud technology through cloud storage database storage space, reduce the complexity of the field audit data retrieval, power is responsible for audit staff quickly document information extraction, improve the integrity and accuracy of audit information preservation, realize real-time information sharing, make the importance level to determine more scientific and reasonable.

3. Audit Risk under Artificial Intelligence Technology

(1) Risk of semantic understanding deviation and information asymmetry

The AI communication routine is set in advance, and there are problems such as inflexible and weak language and emotion, which may make the interrogated personnel appear perfunctory or impatient attitude. If the Mandarin of the interrogated person is not standard, there may be understanding deviation, which will affect the quality of the information obtained. In the audit, the main purpose of man-machine communication is to realize the efficient information exchange between customers and artificial intelligence. However, the audit process of most audit institutions still remains at the use of SQL for data query and the use of spreadsheet software for data screening. Although ChatGPT has improved in the natural language of neural networks, these methods have their inescapable defects, and the ability of robots to recognize dialects and semantics still needs to be improved.

(2) The risk of untrue data and collusion

If the interrogator is familiar with the underlying logic of programming, he may avoid the keywords to make false accounts, so that the growth rate or reduction rate is less than the critical value. If the upload voucher is automatically identified, it may be wrong due to the irregular handwriting of the paper voucher; if the voucher is uploaded manually, the error information may be uploaded due to the negligence and fatigue of the operator. The progress of P diagram technology makes it difficult for artificial intelligence to identify the authenticity of electronic picture vouchers. Both data-driven deviation and human-computer interaction deviation may damage the audit quality and affect the authenticity of accounting information. The designer of the program may also collude with the financial personnel to change the original procedure for personal gain. From a psychological perspective, artificial intelligence lacks the ability to detect lies, microexpressions and other situations. Realizing these requires people's social experience, professional judgment and relevant theoretical knowledge. When the auditees evade, deliberately conceal, and behave abnormally, artificial intelligence often cannot identify. On the premise that audit institutions cannot maintain absolute trust and complete data sharing among all auditees, AI needs to make greater progress in both technology and system if to completely replace auditors to make professional judgment.

(3) the risk of imperfect laws

The newly revised Audit Law of the People's Republic of China and the Regulations on the Advanced Integrated Management of Internet Information Services and other laws and regulations are of great significance for accelerating the construction of a sound legal framework for AI supervision and clarifying the rights and obligations of regulatory agencies. However, in the specific audit projects, some contents have not been included in the category of laws and regulations, which brings troubles to the legal compliance and the definition of power of AI audit mode.

(4) Data security risks

Artificial intelligence audit is based on the data model, and its security risks mainly come from the authenticity and low reliability of the original data, as well as the data leakage caused by viruses or hackers. Due to the different level of national economic development, the construction of digital network and the use of artificial intelligence in different regions are uneven. Various departments and enterprises will not share important information with audit institutions in time out of the consideration of information security, and the problem of information asymmetry will affect the audit. In the era of artificial intelligence, it is difficult to

distinguish the true and false with the huge amount of data, and the privacy is easy to be exposed, which may miss the link or face recognition, leading to the complete disclosure of personal information. Still have may cause the heavy loss of the unit, the enterprise. In the process of data transmission and storage, if hackers break into the internal core database, the possibility of data leakage will increase. For example, if the production process or marketing strategy is leaked, the competitors will imitate its process, reduce the research and development costs, or develop targeted strategies in advance to occupy the market advantage, posing a threat to the company.

4. New Requirements for Audit Procedures under Artificial Intelligence Technology

(1) Audit preparation stage

At this stage, audit institutions should first establish a data sharing mechanism with the auditees, and obtain relevant financial data and business data through the intelligent financial platform. Secondly, audit institutions should combine the business characteristics and risk characteristics of the auditees, and use big data analysis technology to conduct a preliminary assessment of their financial status and internal control, identify high-risk areas, and determine the audit focus. Finally, the audit institutions should set up a professional and compound intelligent audit team, formulate detailed audit plans, and clarify the audit objectives, scope, procedures and methods.

(2) Audit implementation stage

At this stage, audit institutions make full use of the intelligent audit platform, using big data analysis, machine learning and other technologies, to automatically collect, clean and integrate massive financial data, and build an audit data warehouse. Based on the data warehouse, audit institutions carry out multi-dimensional and multi-angle data analysis, identify potential risk points such as misstatement and fraud through abnormal point detection, correlation analysis and other methods, and use visualization technology to generate intuitive analysis reports. At the same time, audit institutions apply natural language processing technology to intelligently analyze unstructured data such as contracts and invoices, extract key information, and assist audit judgment. In the process of implementation, audit institutions should also combine expert knowledge base and audit algorithm model to compare and verify audit evidence to improve the reliability of audit conclusions.

(3) Audit report stage

At this stage, audit institutions use the intelligent audit platform to automatically generate standardized audit report templates to ensure the consistency of the report format and content. Based on the natural language generation technology, the key information such as the data analysis results and risk point identification in the audit implementation stage is automatically filled into the report template to improve the efficiency of report preparation. At the same time, audit institutions apply intelligent audit algorithm to automatically check and verify the report content, identify errors, omissions or contradictions, and improve the quality of the report. In the process of report generation, audit institutions should also consider the information needs of different stakeholders, and use data visualization technology to present audit findings in the form of charts and dashboards, so as to improve the readability and communication of the report.

(4) Follow-up work stage of the audit

At this stage, the audit institution should establish an intelligent tracking mechanism to automatically monitor the rectification of the problems and suggestions raised in the audit report, and urge the audited units to complete the rectification work in time through the system early warning and prompt. At the same time, audit institutions should make full use of the intelligent audit platform to systematically collect and analyze the data, process and results of the previous audit work, summarize the audit experience, optimize the audit model and algorithm, and realize the continuous evolution and iteration of the audit ability. In addition, audit institutions should also pay attention to the mining and dissemination of audit value, use big data analysis technology to dig deep into audit findings, identify industry trends, common problems, etc., and form audit insights and consulting suggestions.

5. Conclusion

The audit goal established by enterprises is the main basis for the audit work, and also the important link of the audit process. Traditional audit work requires auditors to allocate workflow according to the audit objectives, and play the role of checking and filling the gaps. With the continuous expansion of the operation scale of enterprises, the audit workflow design has ushered in the reform and innovation. First of all, it is necessary to judge the authenticity of the data statements. The application of artificial intelligence technology can quickly carry out this work. In the context of the application of artificial intelligence, the purpose of enterprise audit is to reduce audit risks, ensure the accuracy of audit results, provide rich information for audit, reduce audit risks and improve audit quality.

This paper discusses the challenges and opportunities brought by AI technology to the audit field, and analyzes the impact and new requirements of AI technology on audit from four aspects: audit objectives, audit importance, audit risk and audit procedures. Artificial intelligence technology is a double-edged sword. The auditor can use artificial intelligence technology, and the auditors can also use artificial intelligence technology. The objectives, importance and new requirements of audit procedures under artificial intelligence technology are clarified, and the audit subject can make full use of artificial intelligence technology to improve audit efficiency, reduce costs, expand the scope of audit, prevent risks, and simplify the audit process. At the same time, it also puts forward the risks that artificial intelligence technology may face in the audit, including semantic understanding deviation, false data, imperfect law and data security problems. In terms of audit procedures, the document details how to optimize audit work at the stages of audit preparation, implementation, reporting and follow-up work. Overall, although AI technology brings the possibility of innovation in the audit field, it also needs to pay attention to and address the accompanying risks and challenges to ensure the quality and efficiency of audit work.

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References

1 Qualcomm, Quantitative Assessment of Arrest Social Risk—From the Perspective of Automated Decision–Making and Calculation Regulation. *Northern Law* 2021; **15**(**6**): 131–144.

2 Wang Y. Model Algorithm Audit: Theoretical Connotation, International Experience and Audit Framework. *Audit Research* 2023; **3**: 11–18.

3 Zhang Y, Zhang B. The Path Innovation of the Legal System: On the Construction of the Algorithm Audit

System in China. *E–Government* 2022; **10**: 48–61.

4 Zheng S. Algorithm Audit Objective Theory. *Accounting Monthly* 2024; **7**.

5 Yang Y. The Impact of Artificial Intelligence on Audit Work: Evolution Logic and Analytical Framework. *Accounting Monthly* 2024; **9**.

6 Zhang X. A Research on the Application of Enterprise Financial Audit in the Era of Artificial Intelligence. *In the Marketing Industry* 2022; **14**: 122–124.

7 Du J. Research on audit Risk and Prevention of Accounting firms under the Background of ARTIFICIAL Intelligence. *Modern Marketing* 2024; **1**: 49–51.

8 Zhu H. Intelligent Audit Research of the Whole Process Based on Intelligent Finance. *Accounting Study* 2024; **21**: 137–139.

9 Liu G, Yang L. Research Situation, Operation Mechanism and Practical Strategy of Algorithm Audit in the Era of Artificial Intelligence. *Lanzhou Academic Journal* 2024; **9**.

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Article

Research on the Rapid Development of China's Industrial Economy and Its Enlightenment to Vietnam

Le Hai Dang Nguyen * and Junyan Liu

School of Economics and Management, Qingdao University of Science and Technology, Qingdao 266061, Shandong, China

Abstract: In recent years, facing profound adjustments in the global economy, China has clearly formulated and implemented strategies for the development of its industrial economy. These strategies include strengthening infrastructure, enhancing workforce quality, and expanding both domestic and international markets, effectively spurring rapid growth in the industrial sector. Despite significant achievements, China's industrial sector still faces challenges such as environmental pollution, limited innovative capacity in key technological areas, insufficient investment in basic research, and inadequate development of international markets. Drawing from China's experiences, it is suggested that Vietnam adopt similar strategies to modernize and internationalize its own industrial economy. This approach could accelerate Vietnam's industrial progress and boost its global competitiveness. However, Vietnam should adapt these strategies to its own unique context, emphasizing innovation-driven growth, high-value industries, and digital infrastructure development. By balancing state-driven industrial growth with private sector innovation, Vietnam can establish a resilient and competitive industrial base for long-term success.

Keywords: China; industrial economy; Vietnam; development strategy; policy learning

1. Introduction

Industry plays a pivotal and decisive role in the development of a national economy, and countries around the world are making every effort to rapidly advance their industrial economies. In recent years, China has leveraged its advantages, maximizing the international environment, accurately seizing opportunities for major multinational companies to adjust their global strategic layouts, and proactively taking on production capacities from medium to low within its economy. China has experienced explosive growth in its industrial sector, making a significant contribution to the global economy. This development has provided strong momentum, making China one of the fastest-growing economies in the world [1]. Meanwhile, Vietnam is also undergoing a transformation and upgrading its industrial development, coordinated by national policies and strategies, moving towards high-quality industrial development. Vietnam and China, with similar industrial structures and development levels, rely on their geographical advantages and strong regional connections to promote cooperation and development. China's industrial development experience can provide valuable lessons for Vietnam in building a solid foundation for the future.

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* Corresponding: Nguyen Le Hai Dang (haidang01665577747@gmail.com)

2. Overview of China's Industrial Economic Development

2.1. Strong Growth in Industrial Economy

Statistical data from 2013 to 2022 highlights the significant growth of China's industrial economy. Over this decade, China's industrial added value increased from 4230 billion USD to 7170 billion USD, while its GDP grew from 9570 billion USD to 17960 billion USD. This growth not only demonstrates the continuous expansion and technological advancement of China's industry but also reflects the economic shift towards high-tech and service-oriented structures. Particularly in 2021, despite the global economic setback caused by the pandemic, China's industrial added value still achieved a growth of 8.7%, showcasing the robust resilience of its industries and the government's firm commitment to promoting industrial upgrading and transformation. Similarly, Vietnam's industrial economy has also shown a consistent growth trend. Since 2016, Vietnam's industrial added value has grown from 87.71 billion USD to 156.40 billion USD in 2022, with its GDP increasing from 257.10 billion USD to 408.80 billion USD. The proportion of industrial added value in Vietnam's GDP also rose from 34.1% in 2016 to 38.3% in 2022, indicating a strengthening industrial base. Looking ahead, China's industrial economy is expected to maintain its growth momentum. The implementation of national strategies like "Made in China 2025" along with continued investments in new energy and smart manufacturing sectors, will drive the focus towards innovation and high-quality development, thereby promoting a transformation towards a more advanced and sustainable economic structure. These policies and strategies have not only optimized China's industrial structure but also provided valuable development experiences and momentum for other developing countries, especially Vietnam. As industrial automation and intelligence continue to advance, China is expected to maintain a pivotal role in the global economy and set an example for industrial development in neighboring regions (As shown in Table 1).

Table 1. Key Industrial Economic Indicators between China and Vietnam, 2013–2022.

Time	Total Industrial Added Value (Billion USD)		Industrial Added Value Growth Rate (%)		GDP (Billion USD)		Industrial Added Value as a Percentage of GDP (%)	
	China	Vietnam	China	Vietnam	China	Vietnam	China	Vietnam
2013	4230	76.30	8.0	5.1	9570	213.71	44.2	35.6
2014	4510	82.41	7.2	6.2	10480	233.45	43.1	35.3
2015	4520	81.99	5.9	9.2	11060	239.26	40.8	34.2
2016	4450	87.71	6.0	7.8	11230	257.10	39.6	34.1
2017	4910	99.57	5.9	8.3	12310	281.35	39.9	35.4
2018	5510	113.32	5.8	9.0	13890	310.11	39.7	36.5
2019	5510	123.06	4.9	8.2	14280	334.37	38.6	36.8
2020	5560	127.36	2.5	4.4	14690	346.62	37.8	36.7
2021	7000	137.21	8.7	3.6	17820	366.14	39.3	37.5
2022	7170	156.40	3.8	7.8	17960	408.80	39.9	38.3

Source: The World Bank (data.worldbank.org.cn).

Note: The exchange rate between the Chinese Yuan (RMB) and the US Dollar is based on the average rate published by the People's Bank of China for that year.

2.2. Rapid Development of Labor-Intensive Manufacturing Industries

As the world's second-largest economy and the largest in Asia, China surpasses all other nations in terms of global production and sales volumes. This status is attributed to the rapid development of its labor-intensive manufacturing industries, which has significantly enhanced China's competitiveness on the international market and bolstered its global economic influence. Between 2020 and 2021, China quickly recovered from the

pandemic shock, with the export share of labor-intensive products in the global market significantly increasing to 34.7% in 2020 [2]. China has a vast labor market and relatively low labor costs, providing a stable foundation for various labor-intensive industries such as apparel, mobile phones, solar panels, electronics, automobiles, and ships. These industries not only account for nearly a quarter of the global industrial production value but also contribute 40% to China's GDP.

Firstly, the apparel manufacturing industry is one of the foundational industries supporting China's everyday needs, benefiting from an ample supply of textile raw materials such as cotton and silk, along with the continuous growth in per capita income. The industry has shown significant development momentum. Currently, exports of textiles, clothing, shoes, and hats occupy a dominant position in global exports. According to the "2022 Economic Operation Analysis of China's Knitting Industry" the export value of China's knitting industry in 2022 was 114.841 billion USD, accounting for 33.68% of the total national textile and apparel exports. Looking ahead, Chinese apparel companies are moving towards high-end, branded development, with national acceptance expected to improve further, projected to reach 152.92 billion USD by 2025. Moreover, international brands such as Zara, H&M, and Uniqlo have established production bases in China, not only enhancing the international influence of the Chinese clothing industry but also promoting technological innovation and industrial expansion.

Secondly, the industries of mobile phones, solar panels, and electronic products in China show a stable growth trend, benefiting from a series of favorable factors, including low tariff policies, lower labor costs, and domestic tax incentives. These policies have successfully attracted companies from Japan, South Korea, the USA, and the EU to relocate their electronic production lines to China. This not only promotes the development of related supporting enterprises but also consolidates China's position as a major global center for the production and export of electronic products. In the mobile phone sector, China has established the world's largest production base. Chinese brands such as OPPO and Huawei occupy significant positions in the global market. Particularly, in 2023, Huawei achieved a global sales revenue of 98 billion USD and a net profit of 12 billion USD [3]. In the solar panel industry, China also holds a global leadership position. Companies like LONGi Green Energy and JA Solar have performed exceptionally well in both domestic and international markets. Their production capacity and technological innovation have promoted the development of the global solar industry and driven the continuous growth of China's solar exports. In 2021, LONGi Green Energy's solar cell module production and sales rate reached 98.9%, with the highest sales revenue in the Americas at 1.72 billion USD; and the highest gross profit margin in Africa. The overall gross profit margin for the company's overseas sales was 19.2% [4].

Thirdly, the automobile and ship industries in China, in 2023, China's automobile exports reached 4.91 million units, an increase of 57.9% from the previous year, making China the world's largest automobile exporter. Particularly in the field of new energy vehicles, the export volume was 1.203 million units, a 77.6% increase year-on-year, further proving that China's leading position in the global new energy vehicle market is continuously strengthening [5]. Additionally, China's shipbuilding industry also maintains a global leading position. In 2023, based on deadweight tonnage, China's shipbuilding completion, new order volume, and order book each accounted for 52.6%, 64.5%, and 51.1% of the global total, further consolidating China's dominant position in the global shipbuilding market [6].

3. Analysis of the Rapid Development of China's Industrial Economy

3.1. Increasing Foreign Investment Attraction

In recent years, China has actively adopted a series of strategies to vigorously attract foreign investment, thereby accelerating the rapid growth of the industrial economy. Firstly, the Chinese government has introduced a range of preferential policies, such as tax incentives, land benefits, and financial support, to attract high-tech enterprises and multinational companies to establish R&D centers and production bases in China. In 2023, the actual foreign investment attracted by China exceeded 154 billion USD, reaching the third highest level in history. At the same time, 53,766 new foreign-invested enterprises were established nationwide, a year-on-year

increase of 39.7% [7]. Secondly, China has continuously optimized its business environment, simplified administrative approval processes, and reduced corporate operating costs. According to data from the World Bank's business environment report, China's global ranking in the business environment has jumped from 91st to 31st since 2006 [8]. The government has created a favorable investment environment by reforming regulatory systems and improving administrative efficiency, providing convenient services for foreign enterprises. Thirdly, China has established free trade zones in several provinces and cities, implementing more open trade and investment policies. To date, the number of China's free trade pilot zones has expanded to 21. These zones offer a more relaxed operating environment for foreign enterprises, promoting regional economic development and internationalization [9]. China has signed 21 free trade agreements with 30 countries and regions. These cooperation agreements not only provide solid legal protection for foreign investments in China but also significantly enhance the confidence of foreign investors. This increased confidence has effectively promoted the attraction of foreign investment in China's high-tech industries and manufacturing sectors in 2023. Specifically, the proportion of foreign investment attracted to high-tech industries rose to 37.4%, while the share of foreign capital in the manufacturing sector also increased to 27.9% [7].

3.2. Promoting Expansion of Domestic Market Demand

The Chinese government continuously works to raise income levels among residents, thereby fostering consumption growth. According to data from the National Bureau of Statistics, in 2023, the national per capita disposable income was 5490 USD, representing a nominal increase of 6.3% from the previous year [10]. The rise in resident income directly spurred an expansion in consumer demand, providing strong momentum for the development of the industrial economy. Additionally, China has persistently driven the urbanization process, enhancing urbanization rates. By the end of 2022, the permanent urban population rate reached 920.71 million, an increase of 6.46 million people from 2021 [11]. The urbanization process has led to substantial demands for infrastructure construction and real estate development, further boosting demand for industrial products such as steel, cement, and home appliances. Simultaneously, the Chinese government has implemented a series of policies to expand domestic demand, including promoting automobile consumption, supporting the upgrading of green home appliances, and fostering the development of rural markets. These policy measures not only stimulated consumption of industrial products but also promoted the development of related industrial chains. Lastly, China's digital economy has developed rapidly, with burgeoning sectors like e-commerce and mobile payments flourishing. In the first four months of 2024, China's national online retail sales reached 617 billion USD, growing 11.5% over the same period last year [12]. The development of the digital economy has not only facilitated consumers' shopping experiences but also opened new channels for the sales of industrial products.

3.3. Enhancing Labor Quality

Reforms in the education system have improved overall quality, with the higher education enrollment rate reaching 60.2% in 2023, cultivating a large number of highly skilled talents to meet industrial demands [13]. On one hand, there has been a strong emphasis on promoting vocational training, covering manufacturing and service industries, with over 10 million participations in 2023, effectively enhancing professional levels and practical skills. Additionally, enterprises are encouraged to conduct in-house training; many large companies have established internal training centers offering specialized courses to improve production efficiency and competitiveness. At the same time, China has adopted more open policies to attract top international talent. Since upgrading the concept of “Talent as the Primary Resource” to a “Talent-strong Nation Strategy” and incorporating it into the party constitution, to proposing a talent strategy of “Gathering the World's Best Talents for Use” China's talent policies have strongly emphasized the importance of international talents. Since 2001, approximately 440,900 foreign experts have come to work in mainland China, a number that increased to 623, 500 by 2015 and has continued to rise in recent years. International talents have shown many advantages in advancing technological innovation and development in enterprises [14].

3.4. Strengthening Infrastructure Construction

Firstly, in terms of transportation construction, the government continues to increase investments in highways, high-speed railways, ports, and airports, effectively enhancing logistics efficiency and reducing transportation costs. Secondly, in terms of information infrastructure construction, China has accelerated progress. The number of national fiber broadband users has reached 550 million, and the construction of 5G base stations has surpassed 3.377 million units, significantly promoting the digital transformation of enterprises and improving production efficiency [15]. Additionally, numerous modern industrial parks have been built nationwide, attracting a large number of enterprises and forming strong industrial clusters, which have propelled regional economic development. To further promote technological innovation and industrial upgrading, China has extensively constructed multiple national and provincial laboratories, R&D centers, and innovation bases.

4. Major Issues in China's Industrial Development

4.1. Insufficient Development of International Markets

Firstly, although China is one of the world’s largest manufacturing bases, the international recognition of Chinese brands remains relatively low. According to the “2024 Global Top 500 Brand Values” report, out of the top 500 global brands in 2024, 72 were Chinese brands, while American brands accounted for nearly half [16]. This indicates that Chinese brands lack sufficient influence and competitiveness on the international market. Many Chinese companies invest relatively little in brand building, focusing more on short-term market share and sales volume while neglecting long-term brand development. Secondly, China’s export market is overly dependent on a few countries and regions, resulting in weak risk resistance on the international market. For instance, a significant proportion of China's exports go to the USA and the European Union. This high concentration in the export market makes Chinese companies particularly vulnerable in the face of trade frictions and market fluctuations. Data from 2023 shows that trade tensions between the US and China led to a 25% year-on-year decrease in China’s exports to the US, causing significant impacts on some export-dependent businesses [17]. These issues not only limit the international competitiveness of Chinese enterprises but also hinder the further development and transformational upgrading of China's industry.

4.2. Insufficient Technological Innovation Capacity in Key Areas and Relatively Low Investment in Basic Research

In recent years, China has made certain progress in technological innovation, particularly showing significant growth and competitiveness in fields such as new energy, electric vehicles, and mobile communications. However, despite these achievements, there is still a notable deficiency in China's innovation capacity in critical technological areas. Particularly in core components and key technologies, China's dependence on foreign technology remains severe. Take integrated circuits as an example, a critical area for China's technological development. Integrated circuits are the heart of modern electronic devices and are crucial for enhancing the country's technological strength. However, despite significant domestic market demand, Chinese companies' capabilities in designing and manufacturing high-end chips still lag behind international advanced levels. This gap means that in critical technologies and markets, Chinese companies often rely on imports. Moreover, the autonomous innovation capability in areas such as industrial robots, CNC machine tools, and industrial software represents weak links in China's technological development. Despite substantial investments in manufacturing, research and development in these high-end equipment and software areas are still insufficient, particularly in terms of owning core technologies and intellectual property rights. This not only affects the upgrading and transformation of industries but also limits the international competitiveness of high-tech industries. Another serious issue is the insufficient investment in basic research. In China, funding for basic research usually represents a lower proportion of the total R&D budget, restricting the depth and breadth of technological innovation. For a long time, this situation has constrained the efficiency of transforming basic science into applied technology, reducing the originality and disruptiveness of scientific achievements [18].

4.3. Industrial Pollution Damaging the Environment

Although the rapid growth of China's industry has promoted economic development, it has also caused serious environmental issues. Industrial emissions contain harmful substances such as sulfur dioxide and nitrogen oxides, leading to deteriorating air quality, increased acid rain, and negative impacts on water bodies and land resources. Heavy metals and chemical substances in industrial wastewater severely pollute water resources, threatening aquatic ecosystems and human health. Additionally, improper disposal of industrial solid waste leads to soil contamination, affecting agriculture and food safety. Although the Chinese government has recently started to prioritize environmental protection, implementing various regulations and policies to control and reduce industrial pollution, such as the Air Pollution Prevention and Control Law and the Action Plan for Water Pollution Prevention, and achieving initial success in some regions, the progress of environmental governance remains slow. The investment in environmental protection and the application of technologies have not yet fully kept pace with economic development. Therefore, strengthening the enforcement of environmental regulations, enhancing pollution control technologies, and raising public awareness of environmental protection are the major challenges currently facing China [19].

5. China's Industrial Development as a Mirror for Vietnam

5.1. Expanding International Markets and Building Brands

Vietnam should learn from China's experiences and lessons in expanding international markets and building brands, placing greater emphasis on brand development and long-term strategic planning. Firstly, Vietnamese enterprises should strengthen their brand image by providing high-quality products and services to gain recognition in international markets. The government could establish special funds to support enterprises in promoting their brands on international markets, while also encouraging enterprises to go international through tax incentives and low-interest loan policies. This not only helps enterprises expand their market share but also enhances the overall image of the national brand. Secondly, to reduce dependence on a single market, Vietnam should actively explore emerging markets. This includes strengthening trade cooperation with multiple countries, signing free trade agreements, and simplifying customs procedures to lower trade barriers with these countries. This strategy not only aids in diversifying markets but also enhances the market adaptability and global competitiveness of Vietnamese enterprises. Lastly, enhancing production efficiency and product quality is crucial. Vietnam should continuously improve product competitiveness through technological innovation and optimization of the industrial chain. Moreover, introducing and promoting advanced quality management systems, such as Lean production and ISO quality management systems, can not only improve production efficiency but also ensure that product quality meets international standards. By providing technical support and employee training, Vietnamese enterprises will be able to establish a firm foothold in a broader international market.

5.2. Strengthening Investment in Technology and Innovation

Vietnam should focus on developing high-tech industries and fostering innovation. By learning from China's experience, Vietnam needs to establish advanced research and development (R&D) centers and provide comprehensive support to enterprises in researching and applying new technologies. This will not only help enhance the technological level and competitiveness of enterprises but also promote the advancement of the nation's overall scientific and technological capabilities. Simultaneously, the government should introduce relevant policies and incentives to attract more domestic and foreign investment into the high-tech sector, thereby accelerating industrial upgrading. To improve productivity and product quality, Vietnam needs to significantly enhance its education system and vocational training, offering specialized and in-depth training courses. Tailored training plans should be designed to meet the actual needs of various industries, and enterprises should be encouraged to conduct their own employee training to improve skill levels and professional qualifications. Additionally, the government can introduce advanced educational concepts and teaching methods through cooperative education and international exchanges, thereby comprehensively

enhancing the quality of the nation's human resources. By strengthening cooperation with leading international educational institutions and businesses, Vietnam can provide more learning and practical opportunities for its workforce.

5.3. Infrastructure Development

China has significantly improved logistics efficiency and reduced transportation costs through large-scale investments in constructing highways, high-speed railways, ports, and airports. This approach has not only improved the domestic transportation network but also facilitated rapid economic development. Vietnam should learn from this experience and focus resources on building modern transportation infrastructure to enhance logistics efficiency and competitiveness. Simultaneously, Vietnam should also invest in developing advanced communication infrastructure, expanding the coverage of fiber networks, and enhancing the speed and stability of internet access to support the development of the digital economy. Vietnam should actively develop modern industrial parks to attract more foreign investment and provide a favorable operating environment for businesses. These industrial parks should be equipped with comprehensive infrastructure and supporting services, including water supply, electricity, wastewater treatment, transportation, and logistics services. By constructing high-standard industrial parks, Vietnam can create strong industrial clusters, promoting the perfection and upgrading of industrial chains.

5.4. Focus on Environmental Protection and Sustainable Development

Vietnam should implement strict environmental regulations and emission standards, enhance pollution source monitoring, and support enterprises in adopting green production technologies through government financial incentives and technical support. At the same time, it should promote the development of renewable and clean technologies, such as solar, wind, and biomass energy, reducing dependence on fossil fuels and lowering carbon emissions. This not only aids in environmental protection but also creates job opportunities and fosters economic growth. Additionally, Vietnam should introduce and promote advanced clean production technologies, improve energy efficiency, and reduce resource consumption to ensure coordinated development of the economy and the environment. Through government macro-control and financial support, establish a green transformation mechanism for the industrial economy, encourage the development and use of green energy, create an environmentally friendly energy structure, and enhance the enforcement capabilities of environmental protection departments. Establish standards and management schemes for green industrial technologies to achieve the dual goals of ecological environment protection and industrial economic transformation. With these measures, Vietnam will be able to create a better living environment for future generations and achieve sustainable development.

6. Conclusion

China's rapid industrial development provides invaluable lessons for Vietnam as it embarks on its own journey of economic modernization. However, it is crucial that Vietnam carefully evaluates which elements of China's path are applicable and which may not align with its unique circumstances, avoiding the risks associated with blindly following a similar route.

One area where caution is required is China's heavy reliance on labor-intensive industries during its early stages of development. While this approach facilitated rapid economic growth, it has also led to challenges such as wage stagnation, labor exploitation, and environmental degradation. For Vietnam, adopting a strategy that leans too heavily on low-cost labor could hinder its ability to transition into higher-value industries. Instead, Vietnam should emphasize innovation-driven growth, focusing on industries such as technology, high-value manufacturing, and services, which offer greater long-term potential and resilience.

Another consideration is China's significant investment in large-scale infrastructure projects. While these investments have been instrumental in China's growth, Vietnam's smaller economy and resource limitations necessitate a more targeted approach. Rather than replicating China's vast physical infrastructure efforts,

Vietnam should prioritize modernizing digital infrastructure, improving regional connectivity, and supporting industries that rely on technological advancements. This shift would allow Vietnam to tap into global value chains and bolster its competitiveness in the digital age.

Vietnam must also be cautious of China's state-driven model of industrial development. While effective for a country of China's scale, Vietnam may benefit more from a balanced approach that fosters greater private sector involvement and entrepreneurship. Encouraging market-oriented reforms and attracting foreign direct investment will drive competitiveness and innovation, creating a more dynamic and adaptive economy. Additionally, Vietnam should be mindful of China's experiences with overcapacity and inefficiencies in certain state-run sectors, and proactively avoid similar pitfalls by ensuring a balanced and diversified economic structure.

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Author Contributions

L.H.D.N. was responsible for the conception and design of the study, data collection, analysis, and interpretation of data. L. H. D. N. also drafted the manuscript and approved the final version for submission. J. L. provided invaluable support and contributions to this research. Special thanks are extended to her for offering valuable insights and constructive feedback during the preparation of this manuscript. All authors have read and agreed to the published version of the manuscript.

Institutional Review Board Statement

This study did not involve any human or animal subjects and therefore did not require ethics approval. All data used in the study were obtained from publicly available sources.

Informed Consent Statement

Not applicable.

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Not applicable.

Conflicts of Interest

The authors declare no conflict of interest. There are no financial or personal relationships that could have influenced the research presented in this manuscript.

References

1 Kang D. Analysis of the Development Path of China's Industrial Economic Transformation. *Modern Industrial Economy and Informatization* 2024; **14**(**03**): 18–20.

2 Zhao T, Jiang F. Analysis and Policy Recommendations on the Development Prospects of China's Traditional Labor-Intensive Manufacturing Industry. *China Development Observation* 2022; (**11**): 114–117.

3 Huawei. Huawei Investment Holdings Limited Annual Report 2023. Available online: https://www-file.huawei.com/minisite/media/annual_report/annual_report_2023_cn.pdf(accessed on 1 June 2024).

4 Zhao Q, Tian Y. Analysis of the Competitiveness and Market Distribution of China's Solar Cell Exports. *Times Economics and Trade* 2024; **21**(**04**): 102–107.

5 Wang F, Xie R, Li J. Analysis of the Current Status of China's Automobile Industry Development in 2023 and Trend Outlook for 2024. *Automotive Industry Research* 2024; (**01**): 2–7.

6 Xie K, Zhu Z, Jin W, et al. Review and Outlook of the Global Shipbuilding Industry in 2023. *World*

Maritime 2024; **47**(**02**): 1–6.

7 An N. Continued Release of Policy Benefits for "Investing in China" to Attract Foreign Investment. China Reform Daily. Available online: https://www. china-briefing. com/news/foreign-capital-in-china-action-plan-attract-fdi/(accessed on 25 March 2024).

8 Chen T, Yang Y, Liu X. Empirical Analysis and Optimization Study of Business Environment Quality. *Macroeconomic Quality Research* 2024; **12**(**01**): 56–68.

9 Pei T, Li C. Construction of China's Free Trade Pilot Zones: Historical Evolution, Main Experiences, and Practice Approaches. *Journal of Guizhou Party School* 2024; (**03**): 90–98.

10 National per Capita Disposable Income Grew by 6.1% in 2023. China Information Daily. *Available online*: https://english. www. gov. cn/archive/statistics/202401/17/content_WS65a73d26c6d0868f4e8e32e0. html (accessed on 18 January 2024).

11 Sun Z. Dilemmas and Countermeasures of Rural Revitalization under Urbanization. Bulletin of Science and Technology 2024; **40**(**05**): 110–114.

12 Wang K. National Online Retail Sales Reached 4.41 Trillion Yuan in the First Four Months. People's Daily. Available online: https://www. lwxsd. com/pcen/info_view. php? tab=mynews&VID=51762(accessed on 22 May 2024).

13 Bai Z. Gross Enrollment Rate in Higher Education Reached 60.2% in 2023. China Publishing and Media Business Daily. Available online: http://zjnews.china.com.cn/yuanchuan/2024-03-03/414662.html (8 March 2024).

14 Yuan R, Wei H. Introduction of International Talents and Technological Breakthroughs of Chinese Enterprises: Discussion on Accelerating the Construction of an Important Global Talent Center. *China Soft Science* 2024; (**04**): 79–90.

15 Ye Y. Strengthening the Construction of New Infrastructure to Support High-Quality Development. *People's Post and Telecommunications* 2024; (**001**).

16 Editorial. China Building Materials Group Has Been Listed in the Top 500 Global Brand Values for Six Consecutive Years. *China Building Materials* 2024; (**02**): 118.

17 Chen J, Wang X. Trade Frictions under the New China-US Situation: Motives, Impacts, and China's Countermeasures. *Foreign Trade Practice* 2024; **42**(**03**): 37–44.

18 Guo C. Current Issues in China's Industrial Development and Countermeasures for Future High-Quality Development. *Journal of Beijing University of Technology (Social Sciences Edition)* 2019; **19**(**02**): 50-59.

19 Zhang D, Cao H, Zhao H, et al. Development Process and Trends Analysis of Industrial Pollution Control. *Environmental Engineering* 2022; **40**(**01**): 1–7+206.

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Article

Emotional Value in Experiential Marketing: Driving Factors for Sales Growth – A Quantitative Study from the Eastern Coastal Region

Chi LI [1,2] and Yingda Tang [3,*]

[1] *Louis Vuitton China Ltd. Shanghai 200000, China*

[2] *School of Business and Tourism Management, Yunnan University, 650500, China*

[3] *lichi@itc.ynu.edu.cn*

[4] *Anderson School of Management, University of California, Los Angeles, CA 90095, USA*

Abstract: This quantitative research investigates the impact of perceived emotional value in luxury experiential marketing, particularly its influence on the likelihood of repeat purchases. Conducted quantitatively in Shanghai, a city in the Eastern coastal region of China, the research collected data from 206 customers who purchased luxury goods. The findings show a significant positive correlation between customers' perception of emotional value and the likelihood of repeat luxury purchases. Customer satisfaction plays a crucial mediating role in linking customers' perception of emotional value to the likelihood of repeat purchases, while gender does not moderate this relationship. These results underscore the importance of integrating diverse emotional value services into smart marketing strategies. By doing so, businesses can not only enhance customer satisfaction but also significantly improve overall luxury sales performance. This research emphasizes the strategic value of nurturing meaningful customer experiences, thereby strengthening market presence and competitiveness in the dynamic luxury business environment.

Keywords: Smart marketing; emotional value; customer satisfaction; luxury goods

1. Introduction

The luxury goods industry is renowned for its unique purchasing and sales models. Buying luxury items often transcends mere transactional behavior; it embodies a symbolic experience expressing personal taste, status, and social identity. Compared to other sectors like food, fast-moving consumer goods, or tobacco and alcohol, luxury goods exhibit significant distinctions and connections. Consumers of luxury items typically possess refined tastes and specific social status, emphasizing product quality, uniqueness, brand history, and tradition. Simultaneously, they seek emotional satisfaction and special services when purchasing, projecting emotions and identity through these experiences. Marketing and sales strategies in the luxury industry should not rely solely on traditional methods. Intelligent marketing becomes crucial; brands can better understand and meet personalized consumer needs through data analysis and personalized recommendation systems, thereby enhancing shopping experiences and customer satisfaction. Successful data analysis in various fields indicates that the luxury industry can use extreme value mixed modeling to better predict market risks and optimize smart

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* Corresponding: Yingda Tang (ytang1@ucla.edu)

marketing strategies [1,2]. Research on emerging market growth shows that smart marketing can enhance brand strategic positioning and secure a competitive edge in a globalized context [3 – 5]. For example, improving unsupervised domain adaptation methods based on implicit contrastive learning enables brands to enhance data diversity and discernibility, allowing for more accurate capture of market demand and consumer preferences [6].

However, the luxury industry faces challenges. Due to high-end positioning and pricing strategies, consumer purchase decisions are complex and cautious, necessitating brands to build deep trust and effective communication to earn consumer loyalty and support. Additionally, while emotional value theoretically influences consumer decisions significantly, effectively measuring and leveraging this emotional impact requires further empirical research and exploration. Recent BERT-enhanced prompt engineering techniques offer strong support for improving news classification and text analysis in smart marketing, potentially enhancing emotional value delivery [7].

To gain deeper insights into consumer behavior and attitudes towards luxury goods, this study surveyed 206 customers in Shanghai. It found that customer satisfaction mediates between perceived emotional value and repeat purchase intention. Therefore, in enhancing customer satisfaction and promoting luxury goods sales, sales personnel should provide high-quality emotional value services to build closer customer relationships, enhance brand loyalty, and adapt service levels effectively. Cluster-based marketing strategies, successfully applied in logistics and network optimization, offer valuable insights for improving sales personnel scheduling and efficiency in the luxury industry [8, 9]. Leveraging the success of semi-supervised learning in image classification, the luxury industry can better capture market demand dynamics and refine marketing strategies [10].

2. Literature Review

2.1. Smart Marketing: More Than Just a Concept

In recent years, smart marketing has garnered increasing attention, emerging prominently within the contemporary landscape of technological advancements and the expansive luxury market environment. Chiu et al argued that smart marketing transcends mere technological application, embodying a strategic approach that integrates diverse elements such as data analytics, personalized recommendation systems, and enhanced consumer experiences [11].

First and foremost, data analysis plays an indispensable role in smart marketing. Through meticulous data analysis, luxury brands can delve deeply into consumer preferences and behaviors, enabling the formulation of precise marketing strategies [12]. Models like the attention-based DCGAN combined with autoencoders effectively improve classification accuracy, providing strong support for optimizing smart marketing [13]. Research in other fields shows that detailed data analysis can effectively identify potential risks, inspiring the luxury industry to better predict market trends and consumer behavior [14, 15]. By scrutinizing consumer purchase histories, browsing habits, and social media interactions, companies can pinpoint lucrative customer segments and craft targeted marketing campaigns. This precise market positioning not only boosts marketing effectiveness but also slashes operational costs. Studies show that integrating AI with market analysis improves consumer behavior prediction, leading to higher conversion rates and customer retention [16]. Federated learning, by sharing model weights while preserving data privacy, is increasingly used in luxury industry data analysis, enabling market-wide collaboration and enhancing privacy and personalization [17]. Additionally, domain-adaptation deep learning frameworks help brands bridge market distribution boundaries, enhancing understanding of consumer behavior diversity and improving the accuracy and efficiency of smart marketing in the luxury industry [18,19].

Secondly, personalized recommendation systems stand out as a cornerstone of smart marketing [20]. Leveraging advanced algorithms and user behavior data, these systems deliver tailored product suggestions to consumers. Recommendations are curated not only from consumers' historical purchase patterns but also from real-time browsing behaviors and preference analyses. For instance, when consumers explore a particular product category, the system automatically proposes related items, thereby heightening purchase probabilities.

Such personalized recommendations elevate the shopping experience and significantly enhance conversion rates. Research indicates that integrating deep neural network-based image recommendation algorithms in social networks helps consumers more easily find products aligned with their preferences, thereby enhancing the overall shopping experience [21]. Fuzzy-label-based recommendation systems enhance information accuracy and personalized recommendations [22].

Lastly, optimizing consumer experiences constitutes a paramount objective of smart marketing. In the competitive luxury goods sector, differentiation extends beyond products to encompass service and overall experience [23]. Marketers' language proficiency, service acumen, and adaptability are pivotal in this regard. By deeply comprehending consumer needs and psychology, and delivering personalized, attentive service, brands can elevate consumer satisfaction. This premium service experience not only amplifies shopping gratification but also cultivates repeat purchases, fostering enduring customer loyalty. Optimizing emotional value services strengthens the emotional bond between brands and consumers, increasing customer loyalty [24]. Social media, as a digital marketing strategy, significantly influences consumer decision-making, providing key insights for optimizing online services in the luxury industry [25]. Applying active learning to optimize system reliability assessment helps the luxury industry better predict and enhance customer service quality [26–28].

In conclusion, smart marketing enables luxury goods companies to distinguish themselves in a competitive market by leveraging data analysis, personalized recommendations, and optimized consumer experiences. This approach not only boosts marketing efficacy but also enriches consumers' shopping experiences with greater personalization and enjoyment, creating a mutually beneficial outcome for both businesses and their clientele.

2.2. Emotional Value: A Key Element in Demonstrating Customer Respect

Emotional value has become a prominent topic in recent years, describing the emotional and psychological satisfaction consumers derive from purchasing and using products or services [29,30]. This satisfaction is not only based on the functional aspects of the product but also encompasses intangible elements such as brand identity, service quality, and overall consumer experience. Hsu et al argued that the emotional value can be categorized into several types, including pleasure, respect, pride, and belonging. Respect value, especially in luxury consumption, stands out significantly, as luxury goods are not just commodities but symbols of social status [31]. Through acquiring and using luxury items, consumers achieve social recognition and affirm their status, fulfilling their need for respect.

The impact of emotional value on consumer behavior and psychology is profound. From a sales perspective, brands and products that possess high emotional value are more likely to capture consumer attention and trigger purchase decisions [32]. Once an emotional connection is established, consumers tend to exhibit greater brand loyalty and are more inclined to make repeat purchases, thereby enhancing the brand's market share and revenue potential [33]. Therefore, within the luxury goods sector, sales and marketing teams must consistently enhance the emotional value of their brands. This entails delivering personalized services and creating unique experiences that resonate with consumers' emotional desires. By doing so, companies can achieve sustainable business success and maintain a competitive edge in the luxury market.

2.3. Repeat Purchase as a Manifestation of Successful Smart Marketing

Repeat purchase is a cornerstone of successful smart marketing, directly reflecting customer trust and satisfaction with a brand or product [34]. When customers choose to make repeat purchases, they validate their initial decision and affirm the value and quality of service provided. This behavior is more than just a transaction; it signifies positive customer experiences and effective relationship management.

Knox and Walker highlighted that the repeat purchases not only drive sales growth but also play a critical role in sustaining brand development and securing market share [35]. Effective smart marketing strategies go beyond acquiring new customers; they prioritize enhancing customer satisfaction and loyalty through repeat purchases. By continuously refining products, optimizing emotional value service experiences, and executing targeted marketing campaigns, especially in luxury goods markets [36,37], companies can strengthen customer retention, achieve long-term business success, and maintain competitive advantages.

In summary, repeat purchases are a vital indicator of customer loyalty and satisfaction in smart marketing. By focusing on enhancing customer experiences and fostering ongoing relationships, businesses can build a solid foundation for sustainable growth and market leadership.

Currently, most research focuses on how marketers influence customers' repeat purchase behavior by providing emotional value. However, there is relatively little research on the mediating role of customer satisfaction in this relationship and whether gender plays a moderating role. Emotional value as a marketing strategy emphasizes deepening customer brand experience through emotional experiences and connections, thereby enhancing their brand identification and loyalty. Despite the increasing importance of emotional value in customer relationship management, further research and discussion are needed on how to ensure that this emotional value positively influences subsequent sales and the critical role customer satisfaction plays in this process. In particular, whether gender differences will have differential impacts in this process is an important topic for further research. By deeply understanding the complex relationship between emotional value, customer satisfaction, and gender, more profound theoretical support and practical guidance can be provided for the precise formulation of marketing strategies. In summary, in this study, five research hypotheses were proposed to explore the relationships among different variables. These hypotheses focus on the following key variables:

1) Perception of Emotional Value (IV): This refers to the emotional value that consumers perceive when experiencing sales services. This variable serves as the independent variable of the study, used to predict changes in other variables.

2) Likelihood of Repeat Purchases (DV): This refers to the likelihood that consumers, after perceiving emotional value, are willing to purchase the product or service again. This variable is the dependent variable of the study, used to measure consumer behavioral responses.

3) Customer Satisfaction (Mediating Variable): Customer satisfaction mediates the relationship between the perception of emotional value and the likelihood of repeat purchases. The study hypothesizes that customer satisfaction can explain the mechanism through which the perception of emotional value influences the likelihood of repeat purchases.

4) Gender as a Moderator: The study also explores whether gender moderates the relationship between the perception of emotional value, customer satisfaction, and the likelihood of repeat purchases. The aim is to understand if gender influences these relationships (as shown in Figure 1).

Specifically, the five hypotheses include:

Hypothesis 1: There is a relationship between perception of emotional value (IV) and likelihood of repeat purchases (DV).

Hypothesis 2: There is a relationship between perception of emotional value (IV) and customer satisfaction.

Hypothesis 3: There is a relationship between customer satisfaction and likelihood of repeat purchases (DV).

Hypothesis 4: Customer satisfaction mediates the relationship between perception of emotional value (IV) and likelihood of repeat purchases (DV).

Hypothesis 5: Gender moderates these relationships.

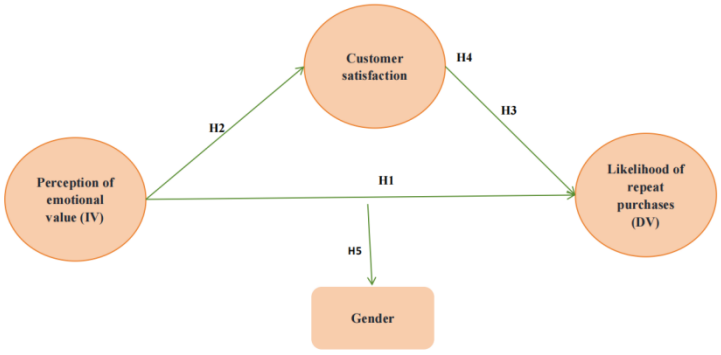

Figure 1. illustrates the research framework.

By validating these hypotheses, the study aims to gain a deeper understanding of the role of emotional value in sales services and to explore the mechanism of customer satisfaction as a mediating variable. It also seeks to confirm whether gender plays a moderating role in these relationships. These findings can help sales personnel in smart marketing strategies to offer diverse emotional value services, enhance customer satisfaction, and increase the likelihood of repeat purchases, thereby achieving sales growth.

3. Methods

This study aims to explore the relationships among perception of emotional value, customer satisfaction, and the likelihood of repeat purchases. It employs the PERVAL scale developed by Sweeney and Soutar to objectively assess customers' perceived emotional value from sales interactions [38]. The PERVAL scale provides a structured approach to measuring emotional value, ensuring a comprehensive evaluation of customer perceptions in sales contexts. This instrument is essential for understanding how emotional value influences customer satisfaction and subsequent purchase behaviors. Additionally, to comprehensively understand overall customer satisfaction with sales personnel, the study utilizes the three-item scale designed by Ramsey and Sohi [39]. This scale assesses customers' satisfaction levels based on the quality of service received, the responsiveness of sales personnel, and overall satisfaction with the sales experience.

Measurement in the study utilizes a five-point Likert scale ranging from 5 (very satisfied/very likely) to 1 (extremely dissatisfied/unlikely), reflecting customers' willingness and likelihood to make repeat purchases. This approach ensures a nuanced assessment of customer satisfaction, crucial for identifying the specific drivers of repeat purchase intentions.

Located in the eastern coastal region of China, Shanghai serves as a key market for luxury goods consumption. Shanghai not only boasts a diverse consumer base but also features a highly competitive retail environment, attracting numerous domestic and international luxury brands. To ensure sample diversity and representativeness, the study selected three major shopping centers with high foot traffic as research sites. These centers include multiple luxury brands such as LV, Gucci, Hermès, and Prada, making them ideal locations for purchasing luxury goods. Additionally, these shopping centers attract a large number of high-end consumers with their rich brand combinations and exceptional shopping experiences, providing a more accurate reflection of the luxury goods market dynamics. This also enhances the practical value of the study's results, offering strong support for the luxury goods industry to improve competitiveness in a rapidly changing market [40–42].

The study successfully collected 206 valid customer questionnaires, achieving a response rate of 98.5%. These data provide a solid foundation for subsequent in-depth analysis, aiding in a more precise understanding of the role of emotional value in sales services and its specific impacts on customer satisfaction and purchase intentions. The high response rate ensures the reliability and validity of the findings, highlighting the study's contribution to the field of emotional value and consumer behavior in retail settings.

Researchers utilized SPSS software for comprehensive data analysis, including descriptive statistics, Pearson correlation exploration, and testing of mediation and moderation models, to comprehensively investigate relationships among variables. These analytical approaches not only helped uncover underlying patterns and correlations in the data but also deepened the understanding of the mechanisms through which emotional value operates in the sales process, providing valuable guidance for further research and practical applications.

4. Results

4.1. Overview of Sample Demographics and Characteristics

To gain an understanding of the sample's characteristics, SPSS was used to conduct a descriptive statistical analysis, focusing on gender, age group, work style, and educational level.

Table 1. Sample Demographics.

Name	Item	Frequency	Percentage (%)	Cumulative Percentage (%)
Gender	Male	72	34.95	34.95
	Female	134	65.05	100.00
Age	26-30 years old	12	5.83	5.83
	31-35 years old	47	22.82	28.64
	36-40 years old	63	30.58	59.22
	41-45 years old	48	23.30	82.52
	46-50 years old	11	5.34	87.86
	Above 51 years old	17	8.25	96.12
	Under 25 years old	8	3.88	100.00
Work style	Agriculture	5	2.43	2.43
	Arts and Culture	21	10.19	12.62
	Construction	5	2.43	15.05
	Education	12	5.83	20.87
	Energy	11	5.34	26.21
	Entertainment and Media	11	5.34	31.55
	Finance	13	6.31	37.86
	Healthcare	9	4.37	42.23
	Information Technology	13	6.31	48.54
	Legal Services	10	4.85	53.40
	Manufacturing	5	2.43	55.83
	Nonprofit Organizations	1	0.49	56.31
	Public Services and Government	10	4.85	61.17
	Real Estate	10	4.85	66.02
	Research and Development	10	4.85	70.87
	Retail	11	5.34	76.21
	Services	13	6.31	82.52
	Telecommunications	10	4.85	87.38
	Tourism and Hospitality Management	15	7.28	94.66
	Transportation and Logistics	11	5.34	100.00
Educational level	Junior High School	19	9.22	9.22
	Master	42	20.39	29.61
	None	10	4.85	34.47
	Ph.D.	26	12.62	47.09
	Primary	19	9.22	56.31
	Senior High School	6	2.91	59.22
	Undergraduate	84	40.78	100.00
Summary		206	100.0	100.0

Table 1 showed a higher proportion of females (65.05%) compared to males (34.95%). The majority fell within the 36-40 (30.58%) and 41-45 (23.30%) age brackets. Participants worked in a variety of industries, with notable representation in arts and culture (10.19%), finance (6.31%), information technology (6.31%), and tourism and hospitality management (7.28%). Regarding educational level, the largest group held undergraduate degrees (40.78%), followed by those with master's degrees (20.39%). The sample included participants with diverse educational backgrounds, ranging from primary school to Ph.D. holders. Overall, the sample comprised 206 respondents, providing a comprehensive overview of various demographic and occupational categories.

4.2. The Relationship Between Perception of Emotional Value (IV) and Likelihood of Repeat Purchases (DV)

To investigate the correlation between the perception of emotional value (IV) and the likelihood of repeat purchases (DV), a Pearson correlation analysis was conducted using SPSS.

Table 2. Overview of Correlation Coefficients between IV and DV.

	Perception of emotional value (IV)
Likelihood of repeat purchases (DV)	0.562**

* $p<0.05$ ** $p<0.01$

Table 2 presented the correlation coefficients between customers' perception of emotional value and their likelihood of repeat purchases. A significant positive correlation was indicated between the two variables, with a correlation coefficient of 0.562, which was significant at the 0.01 level (**p<0.01). This suggested that as consumers' perception of emotional value increased, their likelihood of making repeat purchases also rose.

4.3. The Relationship Between Perception of Emotional Value (IV) and Customer Satisfaction (Mediating Variable)

To examine the relationship between the perception of emotional value (IV) and customer satisfaction (mediating variable), a Pearson correlation test was conducted.

Table 3. Overview of Correlation Coefficients between perception of emotional value and customer satisfaction.

	Perception of emotional value (IV)
Customer satisfaction	0.604**

* $p<0.05$ ** $p<0.01$

Table 3 showed the correlation coefficients between customers' perception of emotional value and their satisfaction. A significant positive correlation was revealed, with a coefficient of 0.604, significant at the 0.01 level (**p<0.01). This indicated that a higher perception of emotional value was associated with increased customer satisfaction.

4.4. The Relationship Between Customer Satisfaction (Mediating Variable) and Likelihood of Repeat Purchases

To analyze the relationship between customer satisfaction (mediating variable) and the likelihood of repeat purchases, researchers utilized SPSS to perform a Pearson correlation assessment.

Table 4. Overview of Correlation Coefficients between perception of emotional value and customer satisfaction.

	Customer satisfaction
Likelihood of repeat purchases (DV)	0.762**

* $p<0.05$ ** $p<0.01$

Table 4 presented the correlation coefficients between customer satisfaction and the likelihood of repeat purchases. The results show a significant positive correlation, with a coefficient of 0.762, significant at the 0.01 level (**p<0.01). This indicates that higher levels of customer satisfaction are strongly associated with an increased likelihood of repeat purchases.

4.5. Testing the Mediating Effect of Customer Satisfaction Between Perception of Emotional Value (IV) and Likelihood of Repeat Purchases (DV)

To investigate whether customer satisfaction (mediating variable) mediates the relationship between perception of emotional value (independent variable) and likelihood of repeat purchases (dependent variable), the mediation model was tested using SPSS.

Table 5. Mediation Effect Test.

Item	Symbol	Meaning	Effect value Effect	95% CI		Standard Error Devalued	*z value /t value*	*p value*	Summary
IV=> Mediator=>DV	a*b	Indirect	0.063	0.085	0.222	0.034	1.827	0.068	
IV=> Mediator	a	X=>M	0.185	0.080	0.290	0.054	3.460	0.001	
Mediator =>DV	b	M=>Y	0.340	0.287	0.393	0.027	12.546	0.000	Full Mediation
IV=>DV	c'	Direct	0.032	-0.010	0.074	0.021	1.496	0.136	
IV=>DV	c	Total Effect	0.095	0.041	0.149	0.028	3.445	0.001	

Table 5 showed the mediation effect test reveals that the independent variable (IV) has a significant indirect effect on the dependent variable (DV) through the mediator, with an effect value of 0.063 and a 95% confidence interval ranging from 0.085 to 0.222, indicating full mediation. The IV significantly impacts the mediator (effect value of 0.185) and the mediator significantly influences the DV (effect value of 0.340). In contrast, the direct effect of the IV on the DV is not significant (effect value of 0.032). The total effect of the IV on the DV is significant (effect value of 0.095), confirming that the mediator fully explains the relationship between the IV and DV.

4.6. Testing for Gender Moderation Effect

To test the gender moderation effect, the SPSS were used and three models were compared, as displayed in Table 6. Model 1 did not consider the gender effect, Model 2 adds the moderator variable (i.e., gender) to Model 1; and Model 3 includes an interaction term between the IV and gender in addition to Model 2.

Table 6. Testing for gender moderation effect (*n*=206).

	Model 1					Model 2					Model3				
	B	**Standard error**	***t***	***p***	***β***	***B***	**Standard error**	***t***	***p***	***β***	***B***	**Standard error**	***t***	***p***	***β***
Constant	4.680	0.034	138.379	0.000**	-	4.680	0.033	141.354	0.000**	-	4.681	0.034	139.052	0.000**	-
IV	0.095	0.028	3.445	0.001**	0.234	0.080	0.027	2.911	0.004**	0.197	0.081	0.029	2.849	0.005**	0.201
Gender						-0.222	0.071	-3.141	0.002**	-0.213	-0.222	0.071	-3.141	0.002**	-0.213

Cont.

	Model 1				Model 2				Model3				
	B	**Standard error**	***t***	***p***	***β***	***B***	**Standard error**	***t***	***p***	***β***	***B***	**Standard error**	***t***	***p***	***β***
IV*gender											0.012	0.055	0.221	0.825	0.015
R 2	0.055					0.099					0.099				
Adjust R 2	0.050					0.090					0.086				
F value	*F* (1,204) =11.865, *p*=0.001					*F* (2,203) =11.123, *p*=0.000					*F* (3,202) =7.397, *p*=0.000				
R 2	0.055					0.044					0.000				
F value	*F* (1,204) =11.865, *p*=0.001					*F* (1,203) =9.865, *p*=0.002					*F* (1,202) =0.049, *p*=0.825				

* $p<0.05$ ** $p<0.01$

Model 1 showed a significant positive effect of the independent variable on the dependent variable (B = 0.095, t = 3.445, p = 0.001, β = 0.234). Model 2 revealed that after adding the gender variable, the effect of the independent variable on the dependent variable remained significant (B = 0.080, t = 2.911, p = 0.004, β = 0.197), while gender had a significant negative effect on the dependent variable (B = -0.222, t = -3.141, p = 0.002, β = -0.213).

However, after including the interaction term between the independent variable and gender, Model 3 showed that the p-value for the interaction term was 0.825, which is far greater than 0.05, indicating that the interaction term is not significant. Therefore, the researcher further compared the F-value and R^2 value results between Model 2 and Model 3.

As displayed in Table 6, the F-value decreased from 11.123 in Model 2 to 7.397 in Model 3. Additionally, the adjusted R^2 value for Model 3 was 0.086, lower than the corresponding value of 0.09 in Model 2. These results suggest that the interaction term did not significantly improve the model's explanatory power. In other words, gender did not play a significant moderating role in this study.

The results of the above analysis indicate that the likelihood of repeat purchases is significantly associated with customers' perception of emotional value and their satisfaction. Specifically, the stronger the perception of emotional value provided by sales personnel, the higher the satisfaction levels among customers, thereby increasing the likelihood of repeat purchases. Furthermore, satisfaction mediates the relationship between perception of emotional value and likelihood of repeat purchases, with gender showing no significant moderating effect in these dynamics. Overall, this study provides valuable insights into understanding smart marketing strategies.

5. Discussion & Conclusion

Firstly, the research findings reveal how sales personnel in the luxury goods market significantly influence customer experience by providing emotional value. Emotional value is not only reflected in the characteristics of the product itself but also in the emotional connections and personalized services established during the sales process. Therefore, companies aiming to enhance customer satisfaction and boost repeat purchase intention need to prioritize the emotional intelligence and service quality of their sales staff.

Secondly, higher customer satisfaction correlates with stronger repeat purchase intentions and increased sales [43 – 45]. Overall, there is a close relationship between high customer satisfaction and strong repeat purchase intentions, directly impacting sales performance and market share growth. Hence, companies should strive to continually elevate customer satisfaction levels by offering superior emotional value and personalized services to enhance customer loyalty and drive sales growth [46-49].

Additionally, customer satisfaction plays a crucial mediating role between perceived emotional value and

repeat purchase intentions, with gender having a minor influence on these relationships. This finding underscores the mediating role of customer satisfaction between emotional value and repeat purchase intentions, irrespective of customer gender. Therefore, when devising marketing strategies, companies should focus on enhancing overall customer satisfaction levels rather than overly considering gender factors.

In summary, companies should enhance training in emotional intelligence for sales personnel to improve their abilities in emotional communication and personalized service delivery, thereby enhancing their capability to provide emotional value. Secondly, optimizing customer experience design by implementing strategies and processes that enhance customer satisfaction is crucial to ensuring positive emotional connections in every interaction. Furthermore, companies can delve deeper into understanding the specific mechanisms through which customer satisfaction affects the relationship between emotional value and purchase intentions, enabling precise adjustments to marketing strategies and service designs to maximize their impact. These recommendations will aid companies in leveraging emotional value and customer satisfaction to enhance sales performance and competitive advantage in the luxury goods market, thereby achieving sustained business success. Moreover, intelligent methods can be also investigated to explore the efficiency of the proposed method [50–52].

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Upon reasonable request, the primary author is prepared to furnish the data that underpins the findings presented in this study. Please feel free to reach out should you require access to this information, as transparency and accessibility are priorities in our research practice.

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Conflicts of Interest

The authors have disclosed that there are no conflicts of interest to declare regarding the publication of this article.

References

1 Qiu Y. Estimation of Tail Risk Measures in Finance: Approaches to Extreme Value Mixture Modeling. *arXiv preprint* 2024; arXiv:2407.05933.

2 Li L, Li Z, Guo F, Yang H, Wei J, Yang Z. Prototype Comparison Convolutional Networks for One-Shot

Segmentation. *IEEE Access* 2024; **12**: 54978–54990.

3 Qiu Y. Financial Deepening and Economic Growth in Select Emerging Markets with Currency Board Systems: Theory and Evidence. *arXiv preprint* 2024; arXiv:2406.00472.

4 Tang Y. Investigating the Impact of Regional Digital Finance Development on Short-run IPO Performance: Empirical Evidence from China. *Journal of Management Science & Engineering Research* 2024; **7**(**2**): 31 –43.

5 Tang Y. Investigating the Impact of Digital Transformation on Equity Financing: Empirical Evidence from Chinese A-share Listed Enterprises. *Journal of Humanities, Arts and Social Science* 2024; **8**(**7**): 1620–1632.

6 Xu H, Shi C, Fan W, Chen Z. Improving Diversity and Discriminability Based Implicit Contrastive Learning for Unsupervised Domain Adaptation. *Applied Intelligence* 2024; **54**(**20**): 1–11.

7 Zhao F, Yu F. Enhancing Multi-Class News Classification through Bert-Augmented Prompt Engineering in Large Language Models: A Novel Approach. In Proceedings of the 10th International Scientific and Practical Conference "Problems and Prospects of Modern Science and Education". Stockholm, Sweden*, 12–15 March 2024*.

8 Hao Y, Chen Z, Jin J, Sun X. Joint Operation Planning of Drivers and Trucks for Semi-Autonomous Truck Platooning. *Transportmetrica A: Transport. Science* 2023; 1–37. DOI: 10.1080/23249935.2023.2266041

9 Hao Y, Chen Z, Sun X, Tong L. Planning of Truck Platooning for Road-Network Capacitated Vehicle Routing Problem. *arXiv preprint* 2024; arXiv:2404.13512.

10 S. Li, P. Kou, Ma M, Yang H, Huang S, Yang Z. Application of Semi-Supervised Learning in Image Classification: Research on Fusion of Labeled and Unlabeled Data. *IEEE Access* 2024. DOI: 10.1109/ ACCESS.2024.3367772.

11 Chiu M-C, Huang J-H, Gupta S, Akman G. Developing a Personalized Recommendation System in a Smart Product Service System Based on Unsupervised Learning Model. *Computers in Industry* 2021; **128**: 103421.

12 Ducange P, Pecori R, Mezzina P. A Glimpse on Big Data Analytics in the Framework of Marketing Strategies. *Soft Computing* 2018; **22**(**1**): 325–342.

13 Xiong S, Zhang H, Wang M. Ensemble Model of Attention Mechanism-Based DCGAN and Autoencoder for Noised OCR Classification. *Journal of Electronic & Information Systems* 2022; **4**(**1**): 33–41.

14 Zhao F, Yu F, Trull T, Shang Y. A New Method Using LLMs for Keypoints Generation in Qualitative Data Analysis. In Proceedings of the 2023 IEEE Conference on Artificial Intelligence (CAI), Santa Clara, CA, USA, 5–6 June 2023.

15 Ye M, Zhou H, Yang H, Hu B, Wang X. Multi-Strategy Improved Dung Beetle Optimization Algorithm and Its Applications. *Biomimetics* 2024; **9**(**5**): 291.

16 Qiu Y, Wang J. A Machine Learning Approach to Credit Card Customer Segmentation for Economic Stability. In Proceedings of the4th International Conference on Economic Management and Big Data Applications ICEMBDA 2023, 27–29 October 2023, Tianjin, China.

17 Li B, Ma Y, Liu Y, Gu H, Chen Z, Huang X. Federated Learning on Distributed Graphs Considering Multiple Heterogeneities. In Proceedings of the ICASSP 2024-2024 IEEE International Conference on Acoustics, Speech and Signal. Processing (ICASSP), Seoul, Korea, 14–19 April 2024.

18 Xiong S, Chen X, Zhang H, Wang M. Domain Adaptation-Based Deep Learning Framework for Android Malware Detection Across Diverse Distributions. *Artificial Intelligence Advances* 2024; **6**(**1**): 13–24.

19 Xiong S, Zhang H. A Multi-model Fusion Strategy for Android Malware Detection Based on Machine Learning Algorithms. *Journal of Computer Science Research* 2024; **6**(**2**): 1–11.

20 Mariani MM, Wamba SF. Exploring How Consumer Goods Companies Innovate in the Digital Age: The Role of Big Data Analytics Companies. *Journal of Business Research* 2020; **121**: 338–352.

21 Du S, Chen Z, Wu H, Tang Y, Li Y. Image Recommendation Algorithm Combined with Deep Neural Network Designed for Social Networks. *Complexity* 2021; **2021**(**1**): 5196190.

22 Chen Z, Fu C, Tang X. Multi-domain Fake News Detection with Fuzzy Labels. In Proceedings of the DASFAA 2023: The 28th International Conference on Database Systems for Advanced Applications, Tianjin, China, 17–20 April 2023.

23 Vickers JS, Renand F. The Marketing of Luxury Goods: An Exploratory Study – Three Conceptual Dimensions. *The Marketing Review* 2003; **3**(**4**): 459–478.

24 Wang Y, Chen Z, Fu C. Synergy Masks of Domain Attribute Model DaBERT: Emotional Tracking on Time-Varying Virtual Space Communication. *Sensors* 2022; **22**(**21**): 8450.

25 Zhao Z, Ren P, Tang M. How Social Media as a Digital Marketing Strategy Influences Chinese Students' Decision to Study Abroad in the United States: A Model Analysis Approach. *Journal of Linguistics and Education Research* 2024; **6**(**1**): 12–23.

26 Zhu Y, Zhao Y, Song C, Wang Z. Evolving Reliability Assessment of Systems Using Active Learning-Based Surrogate Modelling. *Physica D: Nonlinear Phenomena* 2024; **457**: 133957.

27 Ye X, Luo K, Wang H, Zhao Y, Zhang J, Liu A. An Advanced AI-Based Lightweight Two-Stage Underwater Structural Damage Detection Model. *Advanced Engineering Informatics* 2024; **62**: 102553.

28 Wang X, Zhao Y, Wang Z, Hu N. An Ultrafast and Robust Structural Damage Identification Framework Enabled by an Optimized Extreme Learning Machine. *Mechanical Systems and Signal. Processing* 2024; **216**: 111509.

29 Asshidin NHN, Abidin N, Borhan HB. Perceived Quality and Emotional Value That Influence Consumer's Purchase Intention Towards American and Local Products. *Procedia Economics and Finance* 2016; **35**: 639 –643.

30 Yu YT, Dean A. The Contribution of Emotional Satisfaction to Consumer Loyalty. *International Journal of Service Industry Management* 2001; **12**(**3**): 234–250.

31 Hsu FC, Park SH, Miller JC. Segmenting Food Festivalgoers: Experiential Value, Emotional State and Loyalty. *British Food Journal* 2023; **125**(**1**): 29–48.

32 Dubé L, Le Bel J. The Content and Structure of Laypeople's Concept of Pleasure. *Cognition and Emotion* 2003; **17**(**2**): 263–295.

33 Ambler T. Do Brands Benefit Consumers?. *International Journal of Advertising* 1997; **16**(**3**): 167–198.

34 Kuo YF, Hu TL, Yang SC. Effects of Inertia and Satisfaction in Female Online Shoppers on Repeat-Purchase Intention: The Moderating Roles of Word-of-Mouth and Alternative Attraction. *Managing Service Quality: An. International Journal* 2013; **23**(**3**): 168–187.

35 Knox S. Walker D. *Measuring and Managing Brand Loyalty. Journal of Strategic Marketing* 2001; **9**(**2**): 111 –128.

36 Kumar V, Sharma A, Shah R, Rajan B. Establishing Profitable Customer Loyalty for Multinational Companies in the Emerging Economies: A Conceptual Framework. *Journal of International Marketing* 2013; **21**(**1**): 57–80.

37 Kabiraj S, Shanmugan J. Development of a Conceptual Framework for Brand Loyalty: A Euro-Mediterranean Perspective. *Journal of Brand Management* 2011; **18**: 285–299.

38 Sweeney JC, Soutar GN. Consumer Perceived Value: The Development of a Multiple Item Scale. *Journal of Retailing* 2001; **77**(**2**): 203–220.

39 Ramsey RP, Sohi RS. Listening to Your Customers: The Impact of Perceived Salesperson Listening Behavior on Relationship Outcomes. *Journal of the Academy of Marketing Science* 1997; **25**: 127–137.

40 Gu Y, Yan D, Yan S, Jiang Z. Price Forecast with High-Frequency Finance Data: An Autoregressive Recurrent Neural Network Model with Technical Indicators. In Proceedings of the 29th ACM International Conference on Information & Knowledge Management, Virtual Event, Ireland, 19–23 October 2020.

41 Gu Y, Chen K. GAN-Based Domain Inference Attack. In Proceedings of the 2023 AAAI Conference on Artificial Intelligence, Washington, DC, USA, 7–14 February 2023.

42 Gu Y, Sharma S, Chen K. Image Disguising for Scalable GPU-accelerated Confidential Deep Learning. In Proceedings of the 2023 ACM SIGSAC Conference on Computer and Communications Security, Copenhagen, Denmark, 26–30 November 2023.

43 Chen Z, Fu C, Wu R, Wang Y, Tang X, Liang X. LGFat-RGCN: Faster Attention with Heterogeneous RGCN for Medical ICD Coding Generation. In Proceedings of the 31st ACM International Conference on Multimedia, Ottawa, ON, Canada, 29 October–3 November 2023.

44 Chen Z, Fu C, Tang X. Multi-domain Fake News Detection with Fuzzy Labels. In Proceedings of the 28th International Conference on Database Systems for Advanced Applications (DASFAA-2023), Tianjin, China, 17–20 April 2023.

45 Lu L, Chen Z, Lu X, Rao Y, Li L, Pang S. Uniads: Universal Architecture-Distiller Search for Distillation Gap. In Proceedings of the Thirty-Eighth AAAI Conference on Artificial Intelligence, Vancouver, Canada, 20–27 February 2024.

46 Su J, *et al*. GSENet: Global Semantic Enhancement Network for Lane Detection. Thirty-Eighth AAAI Conference on Artificial Intelligence, Vancouver, Canada, 20–27 February 2024.

47 Xu H, Shi C, Fan W, Chen Z. Improving Diversity and Discriminability Based Implicit Contrastive Learning for Unsupervised Domain Adaptation. *Appl Intell* 2024; **54**(**20**): 10007–10017.

48 Luo S, Jiang Z, Chen Z, Liang X. Domain Adaptive Graph Classification. In Proceedings of the ICASSP 2024-2024 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), Seoul, Korea, 14–19 April 2024.

49 Jiang Z, Zhang L, Liang X, Chen Z. CbDA: Contrastive-Based Data Augmentation for Domain Generalization. *IEEE Transactions on Computational Social Systems* 2024; PP(**99**): 1 – 8. DOI: 10.1109/TCSS.2024.3395705.

50 Fu C, *et al*. HAG: Hierarchical Attention with Graph Network for Dialogue Act Classification in Conversation. In Proceedings of the ICASSP 2023-2023 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), Rhodes Island, Greece, 4–10 June 2023.

51 Yin N, *et al*. DREAM: Dual Structured Exploration with Mixup for Open-Set Graph Domain Adaption. In Proceedings of the Twelfth International Conference on Learning Representations, Vienna, Austria, 7 May 2024.

52 Wang Y, *et al*. A Closer Look at Classifier in Adversarial Domain Generalization. In Proceedings of the 31st ACM International Conference on Multimedia, Ottawa ON Canada, 29 October–3 November 2023.

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