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Optimizing Growth in the Agriculture Commodity Exchange Market: A Game-Theoretic Analysis of Transformation Strategies for Chinese Enterprises

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Abstract

Small and mid-sized enterprises (SMEs) have played a significant role in the growth and advancement of the Chinese agriculture sector. However, these enterprises often face challenges in navigating local distribution networks, complying with regulations, and procuring local consumer products, which can hinder the marketing environment and impede economic growth. To address these issues and promote continuous business development, Chinese agriculture enterprises require effective modeling techniques that facilitate transformation to meet evolving requirements. This study proposes a game-theoretic approach, specifically the Mixed Strategy Game-Theoretic Approach (MSGTA), as a decision-making tool for enterprises facing pre-emptive changes. By analyzing oligopoly firm behavior, the MSGTA approach identifies enterprise outcomes, cooperation patterns, and price-fixing strategies, providing decision-making options and incentives within the enterprise structure. The MSGTA approach assists SMEs in the Chinese agriculture market by systematically analyzing product development stages and ensuring the effective adoption of pre-emptive changes. The efficiency of SMEs implementing the MSGTA approach is evaluated by examining statistical relationships between enterprise growth and requirements. By integrating effective modeling techniques, Chinese agriculture SMEs can adapt to changes proactively, enhance their ability to navigate local distribution networks, comply with regulations, and procure local consumer products more effectively, thereby improving the marketing environment and fostering economic growth.

1. Introduction

In the pursuit of optimizing growth within the agriculture commodity exchange market, Chinese enterprises, particularly small and medium-sized enterprises (SMEs), encounter distinctive obstacles pertaining to the navigation of local distribution networks, adherence to regulatory mandates, and access to consumer markets.

To address these challenges and ensure continuous business development, this study proposes a game-theoretic analysis of transformation strategies, specifically focusing on the mixed-strategy game-theoretic approach (MSGTA) [1-3]. The Agriculture Commodity Exchange Market serves as a specialized platform for the trading of agricultural commodities, connecting farmers, traders, processors, and other stakeholders within the agricultural value chain. Its primary objectives include facilitating transparent price discovery through interactions between buyers and sellers, enabling fair market prices based on supply and demand dynamics. This mechanism is beneficial for farmers in determining appropriate selling prices and allows buyers to acquire commodities at competitive rates. Additionally, these markets provide risk management support by offering futures contracts, which allow farmers to hedge against price fluctuations and reduce uncertainty in agricultural production and market conditions [4-8]. This promotes fair competition and enhances market efficiency, playing a vital role in the development of the agricultural sector by driving increased participation, investment, and innovation, leading to improved productivity and income generation. However, challenges related to infrastructure, logistics, market regulations, quality standardization, and the inclusion of smallholder farmers need to be addressed through collaborative efforts among stakeholders to ensure the effective establishment and functioning of Agriculture Commodity Exchange Markets.

The MSGTA approach offers valuable guidelines for effective decision-making in the face of pre-emptive changes. By analyzing oligopoly firm behavior, the approach identifies enterprise outcomes, cooperation patterns, and price-fixing strategies. It incentivizes and provides decision-making options within the enterprise structure, enabling SMEs to make sound decisions and adapt to evolving market conditions. The importance of SMEs in the Chinese economy cannot be overstated. These enterprises make significant contributions to the national economy, employment opportunities, and various key indicators. In China, SMEs accounted for 60% of the Gross Domestic Product (GDP), 50% of tax income, 68% of exports, and 79%

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70 of job creation in 2020 [1-6]. However, the short-term loans decreased from 41.62% to 39.09%

71 from 2018 to 2019. In 2020, the ratio somewhat increased to 1.67%, so the government

72 instructed the SMEs to postpone payment due to the Covid-19 crisis. After the 2020 situation,

73 around 25.73 million SMEs get their loan from financial institutions, which is a high up to

74 4.61% compared to last year [6]. Henceforth, the Chinese government plans to invest in SMEs

75 from 2021 to 2025 to improve their economy. The SMEs definition of China is a little complex

76 compared to the remaining countries. China's government concentrates on the number of

77 employees defined based on the SME promotion law. According to the law, SME business has

78 been categorized into various types, such as the number of employees, assets, industries, and

79 sales. Let the retail business have less than 100 employees and attain less than 10 million

80 Renminbi (RMB) small company [7]. The definition of SMEs in China differs from other

81 countries, with medium-sized enterprises having more than 100 employees and revenue above

82 10 million RMB, while small construction companies have less than 600 employees and 40

83 million RMB. The Chinese government has unique strategies and policies to support business

84 growth, and Chinese companies proactively adapt to change by optimizing strategies and cash

85 flow [9-11]. Pre-emptive changes require leadership, cost reduction, and time, and industries

86 must minimize risks and challenges to improve growth. Five key factors are crucial for SME

87 success in uncertainty. To ensure SME success in uncertainty, businesses must follow five key

88 factors, as illustrated in Figure 1.

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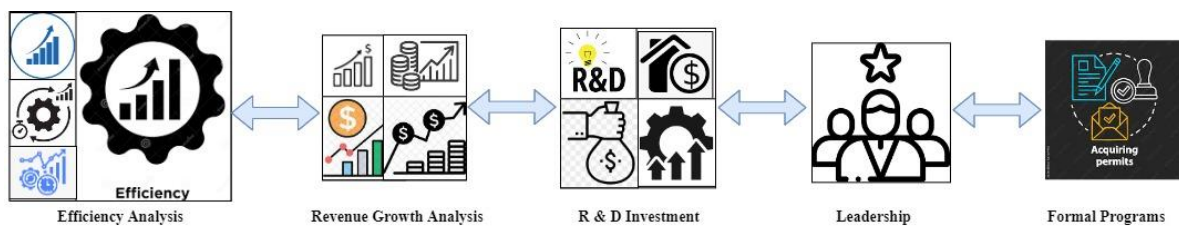
91 **Figure 1:** Factors for Successive Pre-emptive transformation of business strategy.

92 Figure 1 illustrates the pre-emptive transformation of five successive factors: efficiency,

93 revenue growth, R&D investment, leadership, and formal business strategy programs [12]. By

94 applying mixed strategy game theory, the study examines enterprise behavior and identifies

95 effective strategies. It offers tailored guidelines for Chinese enterprises, particularly SMEs, to

96 make informed decisions and enhance growth prospects. In this study, we emphasize the unique

97 contribution of our proposed game-theoretic approach, the Mixed Strategy Game-Theoretic

98 Approach (MSGTA), in guiding decision-making processes for Chinese SMEs facing pre-

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emptive changes. We will clearly articulate how our study fills the existing research gap and offers a novel perspective on optimizing growth in the agriculture commodity exchange market.

1-1-Efficiency Analysis

Leadership and talent development play an important role in the success of an organization. During times of economic difficulty, leaders may consider retrenchment as a means of cutting costs, which can have a negative impact on the organization's growth [13]. Instead, leaders should prioritize the development and training of their employees to help them adapt to transformational changes, while also allocating funds to support this process. This approach can lead to the optimization of non-core areas, cost reduction, and maximization of the organization's function [14-17].

1-2-Revenue Growth Analysis

Companies frequently face difficulties sustaining revenue growth when adapting to pre-emptive changes. Temporary cost-cutting strategies and other measures often fail to achieve the desired revenue growth. Therefore, many enterprises must recalibrate their ideas and focus on their strengths to maximize revenue growth. During this process, (mergers and acquisitions) M&A activities and other business components are analysed to improve industry growth. In light of pre-emptive changes, organizations must possess a strong ability to meet their growth targets [18-21].

1-3- R & D Investment

Long-term orientation in R&D investment is a critical factor for companies, as many prefer to invest externally to manage uncertain changes. R&D investments provide new business initiatives to achieve long-term objectives and are valuable in capital expenditure. External investments can help maximize customer service and personalize client requirements in a cost-effective manner, thereby enhancing services, products, and operations through continuous data assessment.

1-5-Formal Programs

The study aimed to analyse the different strategies for managing central government planners, polluting enterprises, and local government regulators in China. The study explored the tacit collusions in the industry and enterprise incentives using stable evolutionary strategies to ensure the enterprise's robustness and quantitative results [21-22]. Kang et al. (2019) introduced the Game Theoretic approach for analyzing low-carbon tactics in supply chain enterprises. The

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134 study aimed to resolve low-carbon market and government policy-related issues while
135 managing the enterprise [23]. The Stackelberg Game Theoretical (SGT) approach was applied
136 to resolve manufacturing and retailer issues, which were evaluated in the development stage
137 and advanced carbon technology stage behaviour.

138
139 **2. Materials and Methods**

140 This study aims to analyse the pre-emptive transformation of Chinese enterprises to meet their
141 growth requirements. Small and mid-sized industries must be prepared to face sudden changes
142 that can increase enterprise growth. During the analysis, enterprises should focus on business
143 agreements, policies, and development procedures to improve business growth. The study also
144 focuses on the level of professionalization and development required to meet enterprise
145 requirements. The study is conducted in Jiangsu province, China, which is currently receiving
146 government funding to develop small, micro, and medium enterprises. According to a press
147 report dated November 8th, 2022, a significant majority (over 99%) of the 4.066 million
148 registered small, micro, and medium enterprises (SMEs) in Jiangsu province are in need of
149 comprehensive understanding regarding the risks involved and the necessary collateral to foster
150 their organizational growth. In order to maximize the contributions of SMEs, a national
151 inclusive financing service platform has been introduced in Jiangsu, which establishes a
152 structured framework for credit evaluation and enterprise risk monitoring. Consequently,
153 Jiangsu province necessitates the implementation of additional policies and regulations to
154 facilitate the proactive adoption of transformative changes by SMEs, as illustrated in Figure 2
155 (Jiangsu province).

156

157
158 **Figure 2:** East China's Jiangsu Province.

159

160   Figure 2 depicts the location of Jiangsu province, which houses several enterprises contributing

161 to improving production. According to the analysis, 30% of the respondents are large

162 enterprises that produce high-quality products, with 50% being exported to the market and the

163 remaining 50% sold locally. Small and medium enterprises (SMEs) are also planning to develop

164 in Jiangsu to improve the local economy. The Jiangsu government has established adequate

165 infrastructure, including geographical location, information technologies, cheap labor, rich

166 natural resources, and investment policies to improve enterprise production to global standards.

167 This industry has horizontal convergence in the Shengze town of Jiangsu and vertical

168 convergence with big enterprises. Therefore, 62 processes are incorporated into these textile

169 industries that are customized to American and European enterprises. SMEs in the textile

170 industry require low labor costs and are located in the Yangtze River Delta, operating in both

171 international and domestic markets. Due to the high demand for textiles, the industry is

172 incorporated with the research process to develop technology. A small sewing machine

173 enterprise plays an important role in the production chain and is located in Hengshan Town,

174 Jiangsu City, horizontally integrated with large domestic enterprises in Europe, South Korea,
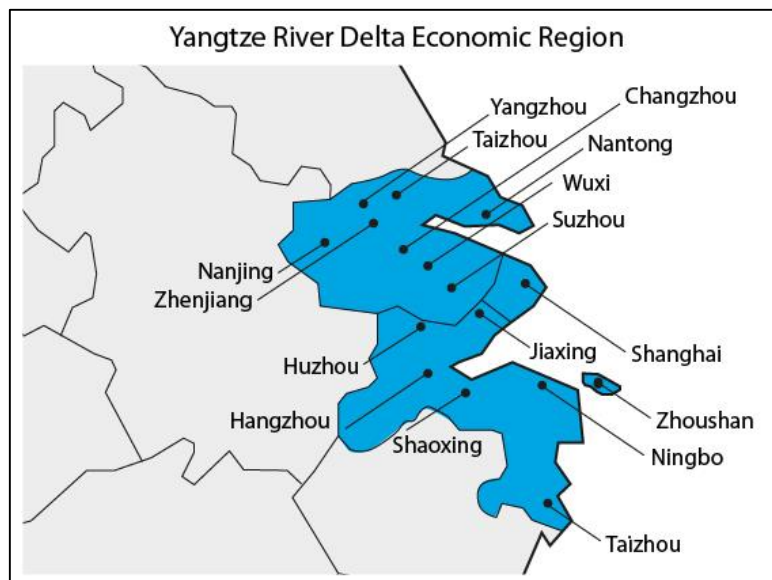
175 Japan, and Shanghai.

176

177
178 **Figure 3:** Economic Region of Jiangsu city.
179

180 Figure 3 demonstrates the economic region of Jiangsu city that almost covers the entire

181 enterprise town belonging to the economic growth. However, these enterprises are highly

182 integrated with China's economic growth; it has a few pitfalls, such as a lack of intellectual

6

183 properties, core technologies, power connection between the local and foreign enterprises,
184 policies, limited funding, and high labour cost.

185
186 **2.1 Recommendation of SMEs Policies**

187 SMEs should have policies that guide both employees and management to meet user
188 requirements. These policies should be designed to strengthen service quality, foster learning
189 from experiences, and enhance competitiveness, technology satisfaction, and financial
190 satisfaction. Figure 4 presents an overview of the policies that are advised for implementation
191 in SMEs. The changes occurring within an enterprise can have a significant impact on the
192 financial department of an SME. Consequently, it is necessary for the policy to concentrate on
193 this specific unit. The policies should encompass the utilization of various financial tools
194 available to SMEs, such as the security market, banking services, fiscal measures, private
195 financing sources, and commercial credits. Moreover, it is vital for the formulated policies to
196 guarantee the dependability and efficacy of credit systems.

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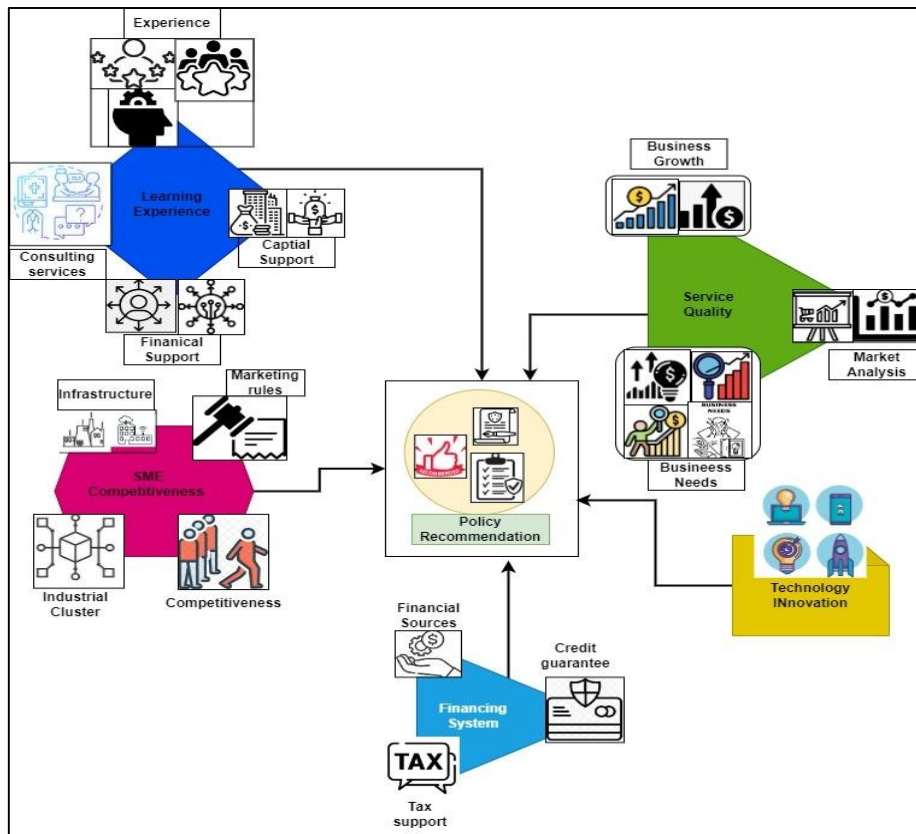
198
199 **Figure 4:** Recommendation of Policies to adapt change Transformation

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2.2 Game Theoretic Analysis for enterprise decision making

The Game Theoretic (GT) framework is employed to handle social situations involving competing players. The GT model utilizes strategic settings to make optimal decisions in SMEs. Rational players are used in the GT model to handle interactive situations. The primary objective of this model is to improve the performance of other players with the help of their payoffs. The game involves two or more quantifiable players, and the GT approach is utilized to identify the most relevant outcomes. The following terms are used to make enterprise decisions.

The GT framework is used to manage business outcomes according to policies that maximize economic profits. The GT framework, specifically the Mixed Strategy Game-Theoretic Approach (MSGTA), can provide valuable insights and support optimal decision-making in SMEs (Small and Medium-sized Enterprises). The GT framework enables SMEs to conduct strategic analysis, considering the behavior of competitors and suppliers, to anticipate responses and make informed decisions that align with growth objectives. It offers a systematic approach to decision optimization, evaluating potential outcomes and payoffs to identify the optimal strategy for maximizing objectives like revenue growth and market share. The game G, which has several groups such as X, Y, and U, is considered, with X defined as the enterprise space in which product development faces various possible changes concerning implementation, cost, and manufacturing processes that aim to maximize production. Y is the industry's possible actions on a specific product with respective realization. U is the enterprise's utility function computed from the X and Y multiplications; $(X * Y \text{ pair of } (x,y); \text{ here } x \in X \text{ and } y \in Y)$/Mixed strategies are applied during the business process analysis to select the business-related decision. The mixed strategy profile lists factors like structural information, requirement details, management, manufacturing, and other details. The possibilities of every factor are explored while investigating the enterprise's requirements and growth. The game theoretic process is applied to predict the decision by considering the enterprise strategies. Consider the industry manufacturing the product m which should satisfy the company's requirements and policies. Therefore, the product manufacturing-related matrix U is described as follows.

$$U = \begin{bmatrix} t_0 + t_1 - d_1 & -s_0 - s_1 + d_1 \ldots\ldots & -s_0 - s_1 + d_1 \\ -s_0 - s_2 + d_2 & t_0 + t_2 - d_2 \ldots\ldots & -s_0 - s_2 + d_2 \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots & \\ -s_0 - s_1 + d_1 & t_0 + t_1 - d_1 \ldots\ldots & -s_0 - s_1 + d_1 \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots & \\ -s_0 - s_n + d_n & -s_0 - s_n + d_n \ldots\ldots & t_0 + t_n - d_n \end{bmatrix} \qquad (1)$$

230 The equation (1) also defined as $U = \|u_{ij}\| = \begin{cases} t_0 + t_j - d_i & when\ i = j \\ s_0 + s_j + d_i & when\ i \neq j \end{cases}$; here, the

231 company income with general unit realization is defined as s_0, cost spent for product unit

232 factors like transportation, storage, and production is defined as t_0, extra income obtained from

233 the company is described as d_i, the number of production in the unit is defined as n, and j is the

234 enterprise-improved production. According to the description, the matrix is formed and

235 analyzed in terms of recommended policy rules. The enterprise, manufacturing strategies,

236 influence of financial factors, and productions directly influence the enterprise's income and

237 expense. Further, the GT matrix is reduced by zero diagonal, which helps make effective

238 business decisions. The improved matrix is obtained by multiplying the equation (1) first row

239 with K1 and the next row with K2 etc. Then the new row value is estimated using equation (2)

240 $t = k_i(t_0 + t_i - d_i); i = 1\ to\ n$ \hfill (2)

241 According to equation (2), the U matrix transformation is performed, and the new matrix is

242 obtained as illustrated in equation (3)

243 $U^* = \|U^*\| = \begin{cases} 0 & if\ i = j \\ -g_i, & if\ i \neq j \end{cases}$ \hfill (3)

244 In equation (3), g_i, is estimated from the $s_0 + s_i + d_i$. Then the solution for three groups

245 $\{X^*, Y^*, v\}$ is derived fro game G and the inequalities of the theorem results are described in

246 equation (3a)

247 $U(X, Y^*) \leq U(X^*, Y^*) \leq U(X^*, Y);$ \hspace{2cm} $x \in X, y \in Y;$

248 $kU(X, Y^*) + a \leq kU(X^*, Y^*) + a \leq kU(X^*, Y) + a;$ \hspace{0.5cm} $x \in X, y \in Y$ \hfill (3a)

249 During the matrix transformation, equation (1) is changed to the zero diagonal, which is done

250 by using the below condition in equation (4).

251 $g_1 > g_2 > \cdots \ldots g_i > \cdots \ldots g_n > 0$ \hfill (4)

252 After checking this condition, the game theoretic is applied to the company activities, and the

253 growth should be analyzed. The enterprise decision depends on the growth value because every

254 change should impact the enterprise requirement. Then the profit obtained policies of the

255 enterprise are defined as $Y = (y_1, y_2, \ldots \ldots y_n)$. Therefore, the game theoretic matrix is defined

256 as $U^*(n, Y^*)$ and the company process is defined with the below relation.

257 $U^*(n, Y^*) = -g_n \sum_{i=1}^{n} y_i = -g_n(1 - y_n) = g_n$ \hfill (5)

258 In equation (5), $g_n > 0$ conditions are utilized to correlate the matrix function with the

259 company profit analysis process that is defined using equation (6)

260 $U^*(i, Y^*) = -g_n(1 - y_n); 1 \leq i \leq n - 1$ \hfill (6)

261 Equation (6) is further defined using equation (7)

9

262 $y \leq 1 - {g_n}/{g_i}; \quad 1 \leq i \leq n-1$ \hfill (7)

263 Mathematical computations are utilized to estimate enterprise activities based on market

264 requirements and policies, with product manufacturing-related participants included in these

265 strategies to maximize economic growth. The game's winning situation is analyzed after

266 changing matrix representations to improve overall economic performance, and the optimal

267 situation of the elements involved in the enterprise is defined as Y.

268 $U^*(i, Y) = -g_i(1 - y_i) = v$ \hfill (8)

269 In equation (8), v is defined as the game value, and the transformation result is computed for

270 every strategy component in the enterprise that is defined using equation (9)

271 $y_i = \dfrac{1 - n(s_0 + s_j + d_i)\sum_{i=I}^{n}\frac{1}{(s_0 + s_j + d_i)}}{(s_0 + s_j - d_i)\sum_{i=I}^{n}\frac{1}{(s_0 + s_j - d_i)}}$ \hfill (9)

272 After computing the enterprise transformation output value, then the market mixed strategies

273 are estimated using equation (10)

274 $x_j = \dfrac{1}{(s_0 + s_j - d_j)\sum_{i=I}^{n}\frac{1}{(s_0 + s_j - d_i)}}$ \hfill (10)

275 Then, finally, the optimal decision about the game is taken by considering the game value that

276 is computed using equation (11)

277 $v = \dfrac{n-1}{\sum_{i=I}^{n}\frac{1}{(s_0 + s_j - d_i)}}$ \hfill (11)

278

279 **2.3 Process Transformation Winning Framework Analysis**

280 The efficiency of small and medium-sized enterprise (SME) performance is evaluated through

281 a three-stage winning framework. The game-theoretic (GT) framework is utilized to determine

282 the optimal timing for industries to embrace pre-emptive changes. The analysis process

283 encompasses rapid assessment, 100-day impacts, and total value realization. Figure 5 visually

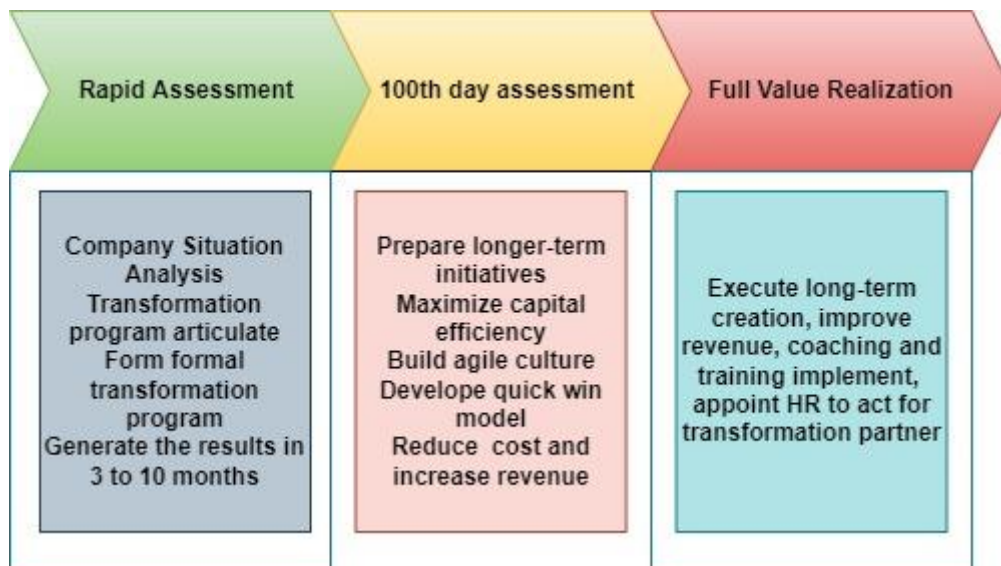284 depicts the winning transformation process.

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287

288 **Figure 5:** Graphical Representation of Winning Transformation Process

289 **3. Result Analysis of Innovation Model Transformation to meet the requirement**

290 SMEs require effective policies and frameworks to adopt innovation model transformations

291 that meet enterprise requirements. Pre-emptive organizational changes can lead to enterprise

292 growth and profit. The growth of the agriculture sector is intricately intertwined with the

293 complex and ever-evolving marketing environment, encompassing market trends, consumer

294 preferences, competitive dynamics, and regulatory frameworks, all of which significantly shape

295 the industry's development, sustainability, and profitability. Market trends reflect changing

296 consumer demands, driving agricultural growth and influencing crop choices and farming

297 techniques. Understanding consumer preferences is crucial for effective product positioning

298 and market connections. Competitive dynamics require differentiation and value propositions,

299 with factors like pricing, branding, and technology playing key roles. Regulatory frameworks

300 impact practices, market access, and competitiveness, emphasizing compliance and promoting

301 sustainability. Adapting to the marketing environment is essential for navigating the agriculture

302 sector successfully. The use of the Matthew Correlation Coefficient (MCC) analysis in our

303 study is based on its suitability for evaluating the performance of classification models in

304 imbalanced datasets. The Pearson Correlation Coefficient, while widely used, has limitations

305 in imbalanced scenarios when assessing predictive performance. It assumes linear relationships

306 and may not capture nonlinear associations or perform well in complex and imbalanced

307 datasets. In such cases, it can be influenced by the dominant class, leading to biased results and

308 inadequate evaluation of minority or rare events.

309

11

3.1 Unplanned and Planned Changes

China's continuous development and crises often lead to both planned and unplanned changes that can significantly affect business growth. The relationship between these factors is described using the Chi-Square Calculator for the 2x2 matrix. The Chi-square test is used to identify the association between categories, with the null hypothesis applied to analyze independent variables. The Chi-square test is utilized to compare the adoption of planned and unplanned changes by SMEs, which is directly dependent on enterprise policies.

$$X^2 = \sum_{i=1}^{r} \sum_{j=1}^{c} \frac{(O_{ij} - E_{ij})^2}{E_{ij}} \tag{12}$$

In equation (12), the observed change frequency of enterprise is denoted as O_{ij} and change in expected frequency is represented as E_{ij}. According to the calculations, 500 small mid enterprises are taken to analyze the relationship between the policies and organizational change. Then the Chi-Square analysis of this process is illustrated in Table 1.

Table 1: Chi-Square Analysis.

Program	Adapted	Unadapted	*Marginal Row Totals*
Planned Changes	374	126	500
Unplanned Changes	305	195	500
Marginal Column Totals	679	321	1000 (Grand Total)

Table 1 illustrates the adoption of planned and unplanned changes by SMEs. The study observed 500 enterprises from the Jiangsu province, of which 374 easily adapted to planned changes and 126 faced difficulties. Industrial policies were developed for each enterprise at every stage of development to facilitate the adoption of unplanned changes. The null hypothesis was used to determine the dependent relationship between policies and changes, with a significance level of 0.05. The values were processed using equation (5), resulting in a value of 21.215 with 1 degree of freedom. The statistical analysis indicated an extremely significant association between the groups, such as planned and unplanned changes.

3.2 Financial Changes

A significant change related to finance has been identified, as continuous financial support is required to purchase new products. The policy must also meet users' requirements and maximize enterprise performance during emergencies. This process is analyzed through hypothesis testing. The following hypothesis illustrates the financial support of the public sector.

12

339 $H1$: No significant or proper relationship between the financial guidance given by the public

340 party and SME success.

341 $H2$: Significant or proper relationship between the financial guidance given by the public party

342 and SME success.

343 The strong relationship between the financial guidance given by the public party and their

344 respective successive factors is explained with the correlation analysis. The correlated

345 regression results are shown in Table 2 which is computed using equation (13)

346 $$correlation\ analysis = \frac{\sum[X(i)-mean(X)]\sum[Y(i)-mean(Y)]}{\sqrt{\sum[X(i)-mean(X)]^2}\sqrt{\sum[Y(i)-mean(Y)]^2}}$$ (13)

347 **Table 2:** H1 Correlation Analysis.

Model	Observed Value (x)	Expected value (y)	A	B	C	D	A. B
Grant of Raw Material	78	54	-3.4	-0.8	11.56	0.64	2.7
Grant of Infrastructure	65	51	-16.4	-3.8	268.96	14.44	62.32
Grant of Startup	87	45	5.6	-9.8	31.36	96.04	-54.88
Grant of Technology	85	54	3.6	-0.8	12.96	167.96	4-2.88
Marketing support	92	70	10.6	15.2	112.36	231.04	161.12
					437.2 (SS$_x$)	342.8(SS$_y$)	168.4(SP$_{xy}$)

348 *Note: A=$X - \bar{X}$, $B = Y - \bar{Y}$, $C = (X - \bar{X})^2$, $D = (Y - \bar{Y})^2$.

349

350 According to Table 2, the probability value is equal to 0.4641, and it has been defined as

351 $(P(x \leq 0.8367) = 0.7679$. Here, the type 1 error occurred, which is rejected in the hypothesis

352 because of the high value (46.41%). The larger probability value indicates that the T test statistic

353 value is equal to 0.8367 which means it strongly supports each other and has a confidentiality

354 index value of 95%. The Pearson correlation results indicated a non-significant medium-

355 positive relationship between X and Y (r(3) = .435, p = .464). Then the correlation analysis of

356 H2 is illustrated in Table 3.

357 **Table 3:** H2 Correlation Analysis.

Model	Observed Value (x)	Expected value (y)	A	B	C	D	A. B
Grant of Raw Material	78	82	-3.4	-0.8	11.56	0.64	2.7
Grant of Infrastructure	65	73	-16.4	-9.8	268.96	96.04	160.72
Grant of Startup	87	85	5.6	2.2	31.36	4.84	12.32
Grant of Technology	85	84	3.6	1.2	12.96	1.44	4.32
Marketing support	92	90	10.6	7.2	112.36	51.84	76.32

13

					437.2 (SS$_x$)	154.8(SS$_y$)	256.4 (SP$_{xy}$)
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358 *Note: A=$X - \bar{X}$, $B = Y - \bar{Y}$, $C = (X - \bar{X})^2$, $D = (Y - \bar{Y})^2$.

359

360 Table 3 represents the correlation analysis and relation between financial guidance and SME

361 success. The correlation coefficient identifies the relationship between -1 and 1. This coefficient

362 is used to predict the linear interdependence of the set, and the two compute the direction and

363 strong relation between financial guidance and enterprise success. The computed value

364 belonging to +1 value then both variables have a strong relationship, -1 means a negative

365 relationship value, and the value between +1 and -1 has a linear relationship. Table 2 value is

366 computed using the below computations.

$$\bar{x} = \frac{78+65+ \cdots +85+92}{5} = 81.4$$

$$\bar{y} = \frac{82+73+ \cdots +84+90}{5} = 82.8$$

367 Σ(x - x̄)2 = (78-81.4)2+(65-81.4)2+ ··· +(85-81.4)2+(92-81.4)2 = 437.2

368

369 Σ(y - ȳ)2 = (82-82.8)2+(73-82.8)2+ ··· +(84-82.8)2+(90-82.8)2 = 154.8

370

371 Σ(x - x̄)(y - ȳ) = (78-81.4)*(82-82.8)+(65-81.4)*(73-82.8)+ ··· +(85-81.4)*(84-82.8)+(92-

372 81.4)*(90-82.8) = 256.4

$$SXY = \frac{\Sigma(x - \bar{x})(y - \bar{y})}{n - 1}$$

$$SXY = \frac{256.4}{5 - 1} = 64.1$$

$$r = \frac{\Sigma(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{(\Sigma(x_i - \bar{x})2\Sigma(y_i - \bar{y})2)}}$$

$$r = \frac{256.4}{\sqrt{(437.2*154.8)}} = 0.9856$$

Alternatively, $r = \dfrac{SXY}{SXSY}$

$$r = \frac{64.1}{10.4547*6.2209} = 0.9856$$

Test Calculations:

$$S = \sqrt{\left(\frac{1 - r2}{n - 2} \right)}$$

$$S = \sqrt{\left(\frac{1 - 0.98562}{5 - 2} \right)} = 0.09769$$

14

$$stat = \frac{r - 0}{S}$$

$$stat = \frac{0.9856 - 0}{0.09769} = 10.089$$

373 $p = p(x \leq 10.089) = 0.999$

374 p-value = 2 * Min(p, 1 - p) = 2 * Min(0.999, 0.001037) = 0.002074.

375

376 According to the above computations, the probability value is equal to 0.002074, and it has

377 been defined as P (x≤10.089)= 0.999. Here, the type 1 error occurred, which is rejected in the

378 hypothesis because of the small value (0.21%). The smaller value indicates that the T test

379 statistic value is equal to 10.089 which means it strongly supports each other and has a

380 confidentiality index value of 95% [0.792, 0.9991]. The Pearson correlation results indicated a

381 non-significant medium-positive relationship between X and Y (r(3) = .435, p = .464). From

382 the analysis, the H1 has a strong correlation (0.9856), covariance has 64.1, and five different

383 category supports are utilized in which 50 samples are utilized to evaluate the regression

384 analysis. The statistical analysis clearly states that a significant positive relationship has been

385 maintained between X and Y with respective categories defined in Table 2.

386

387 **3.3 Structural Changes**

388   For small and medium-sized enterprises (SMEs), making structural changes in terms of

389 management and organization of employee activities is of utmost importance. The success of

390 an enterprise relies heavily on its business strategies and structure, which may need to be

391 adjusted based on evolving requirements to optimize productivity and ensure sustainability. In

392 order to implement these changes and effectively address associated issues, financial support is

393 essential. To evaluate the efficiency of SMEs following multiple changes, the reliability factor

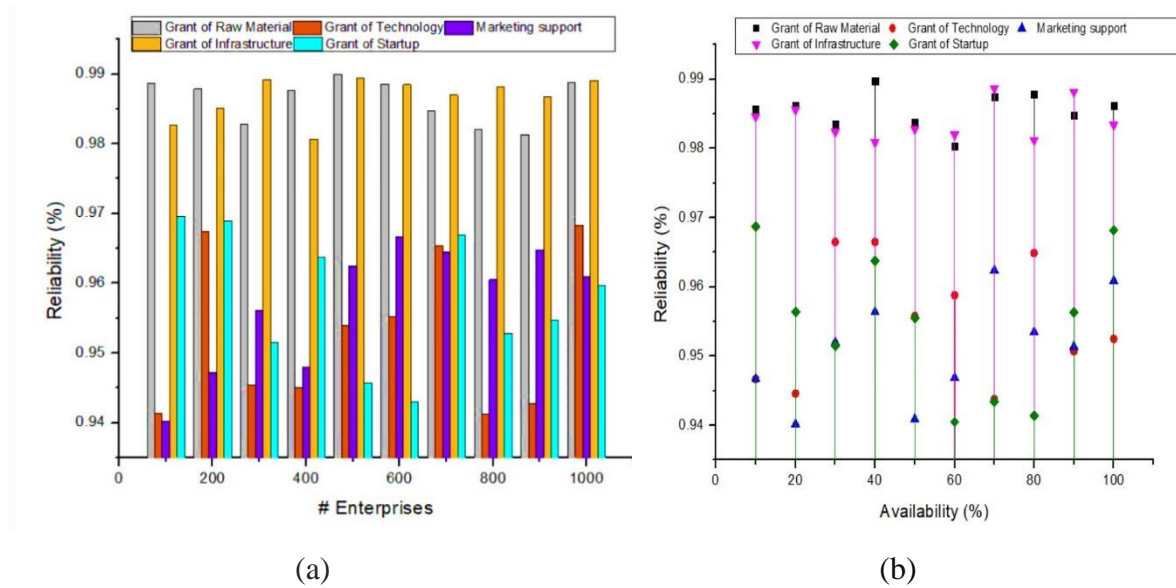394 is employed, and the outcomes are presented in Figure 6.

395

15

(a)   (b)

Figure 6: Reliability Analysis.

Figure 6 illustrates the reliability analysis of SMEs across various enterprise factors. Industries require diverse support models and resources from different perspectives. The reliability analysis of structural changes and resource availability across various enterprises is demonstrated in Figures 6(a-b).

3.4 Managerial Capacity and Policy Incentive Changes

Managerial capacity and policy incentive changes are crucial factors for SMEs. Managerial capacity plays a vital role in observing employee processes, abilities, and contributions to increase economic growth [14-18]. This capacity also impacts employee policy incentives. Therefore, the game theoretic approach is used to recommend policies for various management techniques and minimize computation difficulties. The relationship between the adopting process of managerial capacity and policy incentive changes is evaluated using Cronbach's alpha metrics, and the results are illustrated in Table 4.

Table 4: Cronbach's Alpha (CA) Analysis.

| Scale	Questions	Things	CA
Small and Medium Enterprise success	8	9	0.934
Financial Guidance	15	6	0.765
Private sector support impact on SME	10	6	0.78
Public sector support impacts SME	12	7	0.783
Policy Incentive changes	8	5	0.834
Managerial Capacity monitoring	8	7	0.789
Program based training	8	6	0.823

Table 4 demonstrates the internal consistency of SME employees, measured by analyzing a questionnaire. The Cronbach's Alpha value, ranging between 0 and 1, indicates the factors

16

416   related to enterprise reliability and economic growth. The system performance is determined

417   using the Matthew Correlation Coefficient and Accuracy, computed using the equations below.

418   $$MCC = \frac{(TP*TN)-(FN*FP)}{\sqrt{(TP+FP)(TP+FN)(TN+FP)(TN+FN)}}$$ (14)

419   $$Accuracy = \frac{Number\ of\ correct\ decision\ in\ business}{Total\ Number\ of\ decision\ in\ busness}$$ (15)

420   In equation (14) & (15), TP is denoted as True positive -correctly making the decision, TN-true

421   negative- wrongly identified right decision, FN-False Negative-false identified decision, and

422   FP-False positive -rightly identified wrong business decision. According to the computations,

423   the obtained results are illustrated in Figure 7.

424

425   **(a)**   **(b)**
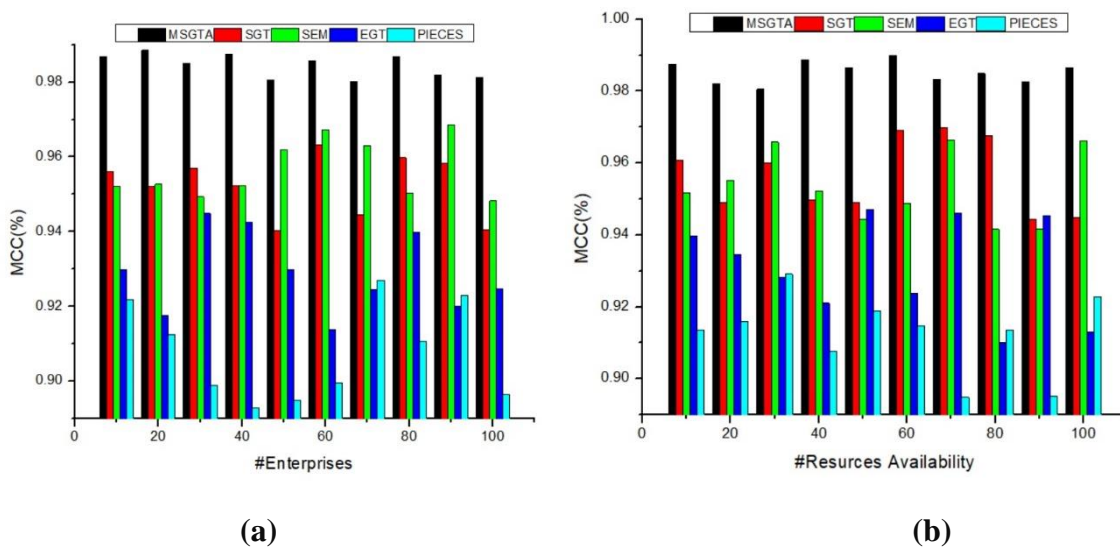
426   **Figure 7:** Matthew Correlation Analysis (a) Enterprises and (b) Resource Availability.

427   Figure 7 illustrates the Matthew Correlation Analysis, computed from the true positive, false

428   negative, true negative, and false positive computations of business decisions. The MSGTA

429   approach recognizes every business strategy with business economy policies, investigates user

430   requests for different enterprises, and evaluates resource availability to make accurate decisions

431   [18-21]. Figure 7 indicates that the introduced system achieves a high MCC value compared to

432   other modeling techniques described in the literature survey [22-25]. Figure 8 illustrates the
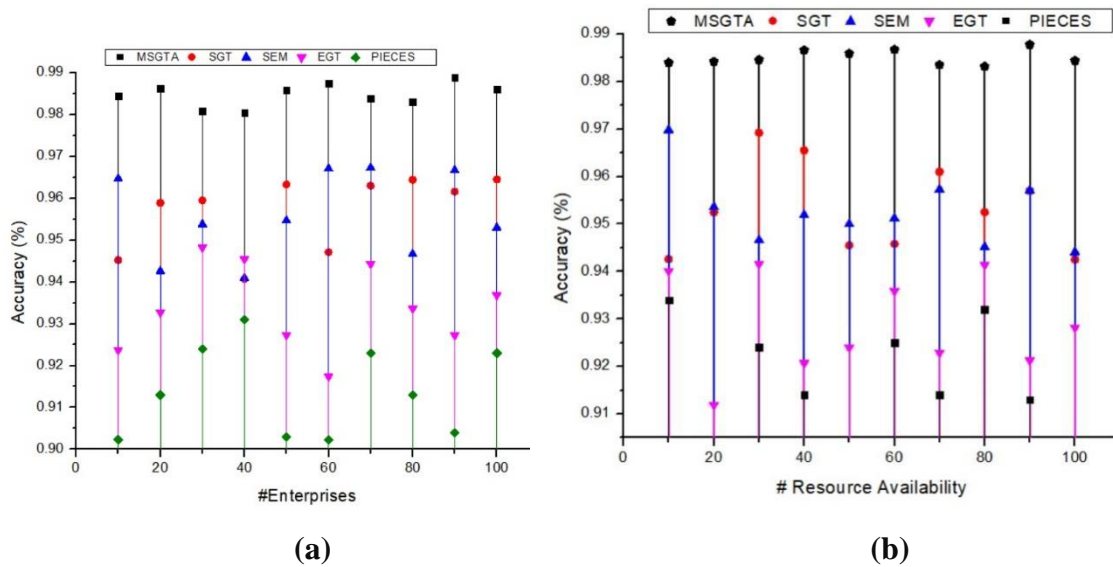
433   respective Accuracy.

434

435 **(a)** **(b)**

436 **Figure 8:** Accuracy Analysis (a) Enterprises and (b) Resource Availability.

437 Figure 8 clearly illustrates that the MSGTA approach achieves excellent performance with the

438 highest accuracy rates of 98.3% for enterprises and 98.6% for resource availability. However,

439 the obtained accuracy is relatively lower than other methods, such as SGT (0.95%, 0.956%),

440 EGT (0.92%, 0.93%), SEM (0.92%, 0.953%), and PIECES (0.913%, 0.916%). Small and mid-

441 sized enterprises can benefit from utilizing the Game-theoretic approach, specifically the Mixed

442 Strategy Game-Theoretic Approach (MSGTA), to navigate pre-emptive changes and meet their

443 enterprise growth requirements in a dynamic marketing environment [26-36]. A study utilizes

444 game theory to analyze the competition between container port hubs, with a specific focus on

445 Busan and Shanghai, offering valuable insights into their strategic dynamics [37].Recent studies

446 in China have examined the impact of the low-carbon strategy on digital transformation in

447 manufacturing, developed stock intelligent investment strategies, explored the influence of

448 group identity on bidding behavior, investigated innovation inequality, and analyzed the

449 relationship between fintech, financial constraints, and outward foreign direct investment [38-

450 42]. Additionally, researchers have assessed changes in CSR efficiency in the Chinese food

451 industry due to the COVID-19 pandemic [43-44]. This study aims to optimize the design of a

452 hybrid energy system using a modified-gray wolf algorithm, develop a project management

453 strategy for urban flood disaster prevention, and propose a novel hybrid algorithm for efficient

454 task scheduling in distributed systems [45-47].

455

456 **4. Conclusion**

457 The agriculture sector's growth is closely tied to the dynamic marketing environment, which

458 includes market trends, consumer preferences, competition, and regulations. Market trends and

18

459 consumer demands shape agricultural growth, influencing crop selection and farming methods.
460 Understanding consumer preferences is vital for positioning products and establishing market
461 connections. Competition necessitates differentiation through pricing, branding, and
462 technology. Regulatory frameworks impact practices, market access, and competitiveness,
463 emphasizing compliance and sustainability. Adapting to the marketing environment is crucial
464 for success in the agriculture sector. The article evaluates the impact of these strategies on
465 growth, competitiveness, and economic development. By integrating game-theoretic analysis
466 and market-specific insights, the study contributes new perspectives and practical
467 recommendations for fostering growth in the agriculture commodity exchange market.
468 Policymakers and industry stakeholders can also benefit from the insights provided to create a
469 supportive environment for Chinese enterprises in this market. SMEs are typically established
470 to pursue business opportunities within the economy, and they hold a unique position within
471 both the economy and the marketplace.

472
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