

1 **ACCEPTED ARTICLE**

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

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15 **Abstract**

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

35 **Keywords:** Small and mid-sized enterprises, Game-theoretic approach, Mixed Strategy Game-
36 Theoretic Approach (MSGTA), Agriculture sector, Pre-emptive changes, Marketing
37 environment.

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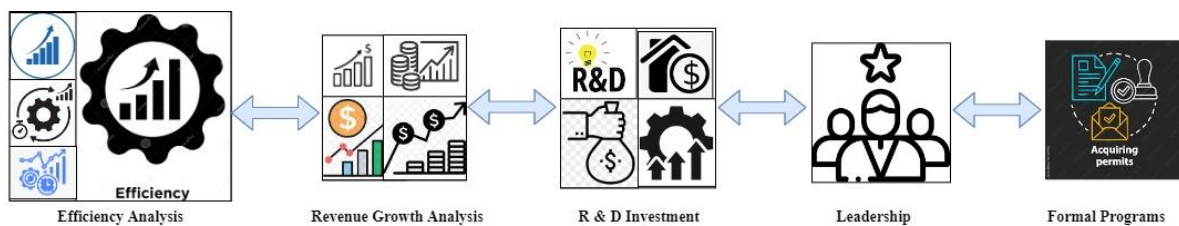
39 1. Introduction

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

44 To address these challenges and ensure continuous business development, this study proposes
45 a game-theoretic analysis of transformation strategies, specifically focusing on the mixed-
46 strategy game-theoretic approach (MSGTA) [1-3]. The Agriculture Commodity Exchange
47 Market serves as a specialized platform for the trading of agricultural commodities, connecting
48 farmers, traders, processors, and other stakeholders within the agricultural value chain. Its
49 primary objectives include facilitating transparent price discovery through interactions between
50 buyers and sellers, enabling fair market prices based on supply and demand dynamics. This
51 mechanism is beneficial for farmers in determining appropriate selling prices and allows buyers
52 to acquire commodities at competitive rates. Additionally, these markets provide risk
53 management support by offering futures contracts, which allow farmers to hedge against price
54 fluctuations and reduce uncertainty in agricultural production and market conditions
55 [4-8]. This promotes fair competition and enhances market efficiency, playing a vital role in
56 the development of the agricultural sector by driving increased participation, investment, and
57 innovation, leading to improved productivity and income generation. However, challenges
58 related to infrastructure, logistics, market regulations, quality standardization, and the inclusion
59 of smallholder farmers need to be addressed through collaborative efforts among stakeholders
60 to ensure the effective establishment and functioning of Agriculture Commodity Exchange
61 Markets.

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

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.**



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-**

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

101 102 **1-1-Efficiency Analysis**

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

110 111 **1-2-Revenue Growth Analysis**

112 Companies frequently face difficulties sustaining revenue growth when adapting to pre-emptive
113 changes. Temporary cost-cutting strategies and other measures often fail to achieve the desired
114 revenue growth. Therefore, many enterprises must recalibrate their ideas and focus on their
115 strengths to maximize revenue growth. During this process, (mergers and acquisitions) M&A
116 activities and other business components are analysed to improve industry growth. In light of
117 pre-emptive changes, organizations must possess a strong ability to meet their growth targets
118 [18-21].

119 120 **1-3- R & D Investment**

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

127 128 **1-5-Formal Programs**

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

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

158

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.

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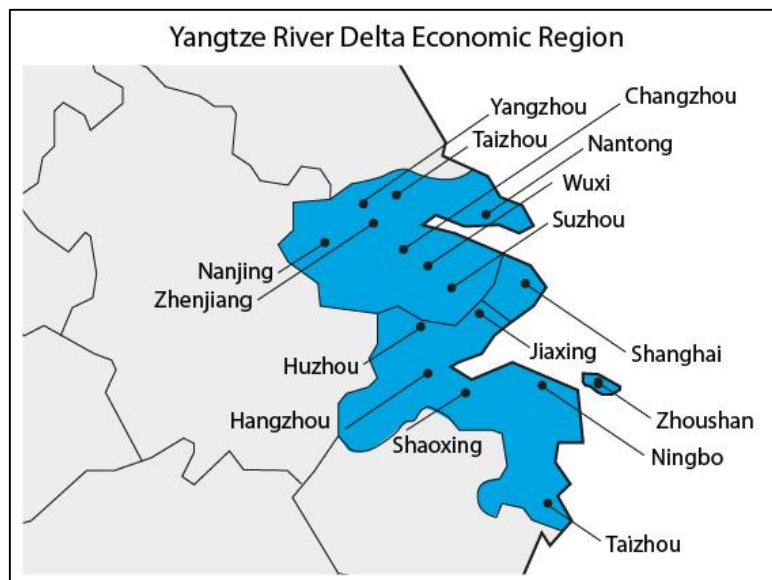


Figure 3: Economic Region of Jiangsu city.

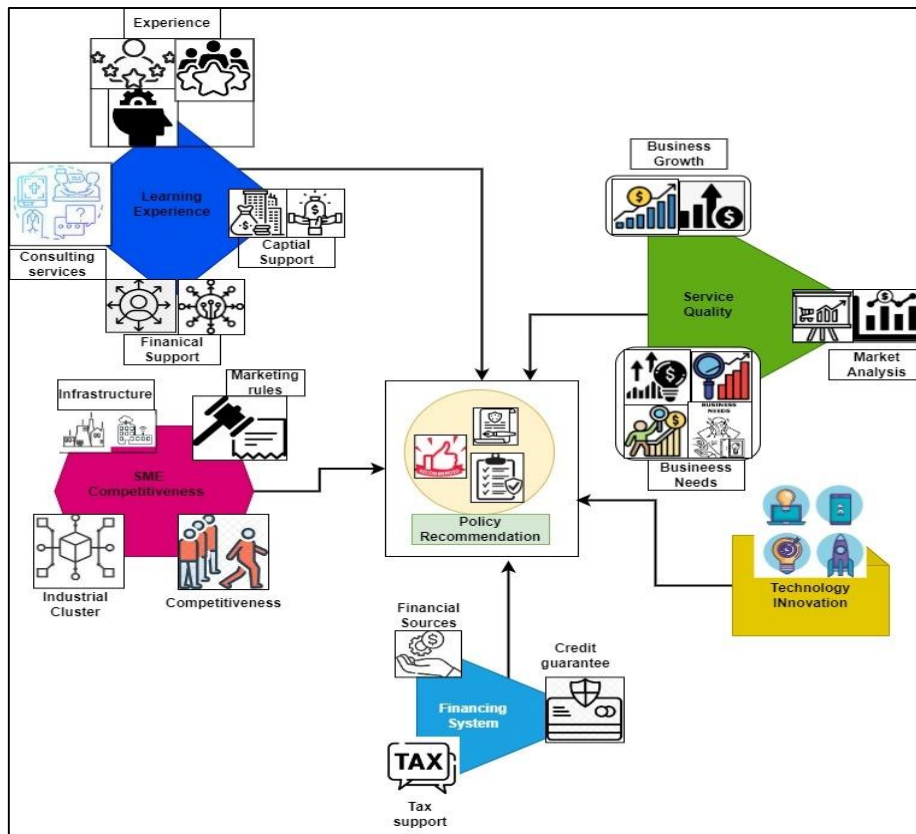
177
178 Figure 3 demonstrates the economic region of Jiangsu city that almost covers the entire
179 enterprise town belonging to the economic growth. However, these enterprises are highly
180 integrated with China's economic growth; it has a few pitfalls, such as a lack of intellectual
181
182

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.

197



198

199

200

Figure 4: Recommendation of Policies to adapt change Transformation

201 **2.2 Game Theoretic Analysis for enterprise decision making**

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

209 The GT framework is used to manage business outcomes according to policies that maximize
 210 economic profits. The GT framework, specifically the Mixed Strategy Game-Theoretic
 211 Approach (MSGTA), can provide valuable insights and support optimal decision-making in
 212 SMEs (Small and Medium-sized Enterprises). The GT framework enables SMEs to conduct
 213 strategic analysis, considering the behavior of competitors and suppliers, to anticipate responses
 214 and make informed decisions that align with growth objectives. It offers a systematic approach
 215 to decision optimization, evaluating potential outcomes and payoffs to identify the optimal
 216 strategy for maximizing objectives like revenue growth and market share. The game G, which
 217 has several groups such as X, Y, and U, is considered, with X defined as the enterprise space
 218 in which product development faces various possible changes concerning implementation, cost,
 219 and manufacturing processes that aim to maximize production. Y is the industry's possible
 220 actions on a specific product with respective realization. U is the enterprise's utility function
 221 computed from the X and Y multiplications; $(X * Y \text{ pair of } (x, y); \text{ here } x \in X \text{ and } y \in$
 222 $Y)$ /Mixed strategies are applied during the business process analysis to select the business-
 223 related decision. The mixed strategy profile lists factors like structural information, requirement
 224 details, management, manufacturing, and other details. The possibilities of every factor are
 225 explored while investigating the enterprise's requirements and growth. The game theoretic
 226 process is applied to predict the decision by considering the enterprise strategies. Consider the
 227 industry manufacturing the product m which should satisfy the company's requirements and
 228 policies. Therefore, the product manufacturing-related matrix U is described as follows.

229
$$U = \begin{bmatrix} t_0 + t_1 - d_1 & -s_0 - s_1 + d_1 & \dots & \dots & -s_0 - s_1 + d_1 \\ -s_0 - s_2 + d_2 & t_0 + t_2 - d_2 & \dots & \dots & -s_0 - s_2 + d_2 \\ \dots & \dots & \dots & \dots & \dots \\ -s_0 - s_1 + d_1 & t_0 + t_1 - d_1 & \dots & \dots & -s_0 - s_1 + d_1 \\ \dots & \dots & \dots & \dots & \dots \\ -s_0 - s_n + d_n & -s_0 - s_n + d_n & \dots & \dots & t_0 + t_n - d_n \end{bmatrix} \quad (1)$$

230 The equation (1) also defined as $U = \|u_{ij}\| = \begin{cases} t_0 + t_j - d_i & \text{when } i = j \\ s_0 + s_j + d_i & \text{when } i \neq j \end{cases}$; 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 $t = k_i(t_0 + t_i - d_i); i = 1 \text{ to } n$ (2)

241 According to equation (2), the U matrix transformation is performed, and the new matrix is
 242 obtained as illustrated in equation (3)

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

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 from game G and the inequalities of the theorem results are described in
 246 equation (3a)

$$247 \quad U(X, Y^*) \leq U(X^*, Y^*) \leq U(X^*, Y); \quad x \in X, y \in Y;$$

$$248 \quad kU(X, Y^*) + a \leq kU(X^*, Y^*) + a \leq kU(X^*, Y) + a; \quad x \in X, y \in Y \quad (3a)$$

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).

$$251 \quad g_1 > g_2 > \dots \dots g_i > \dots \dots g_n > 0 \quad (4)$$

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 $Y = (y_1, y_2, \dots \dots y_n)$. Therefore, the game theoretic matrix is defined
 256 as $U^*(n, Y^*)$ and the company process is defined with the below relation.

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

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)

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

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

262 $y \leq 1 - g_n/g_i; 1 \leq i \leq n - 1$ (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 $U^*(i, Y) = -g_i(1 - y_i) = v$ (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 $y_i = \frac{1-n(s_0+s_j+d_i) \sum_{i=1}^n \frac{1}{(s_0+s_j+d_i)}}{(s_0+s_j-d_i) \sum_{i=1}^n \frac{1}{(s_0+s_j-d_i)}}$ (9)

272 After computing the enterprise transformation output value, then the market mixed strategies
 273 are estimated using equation (10)

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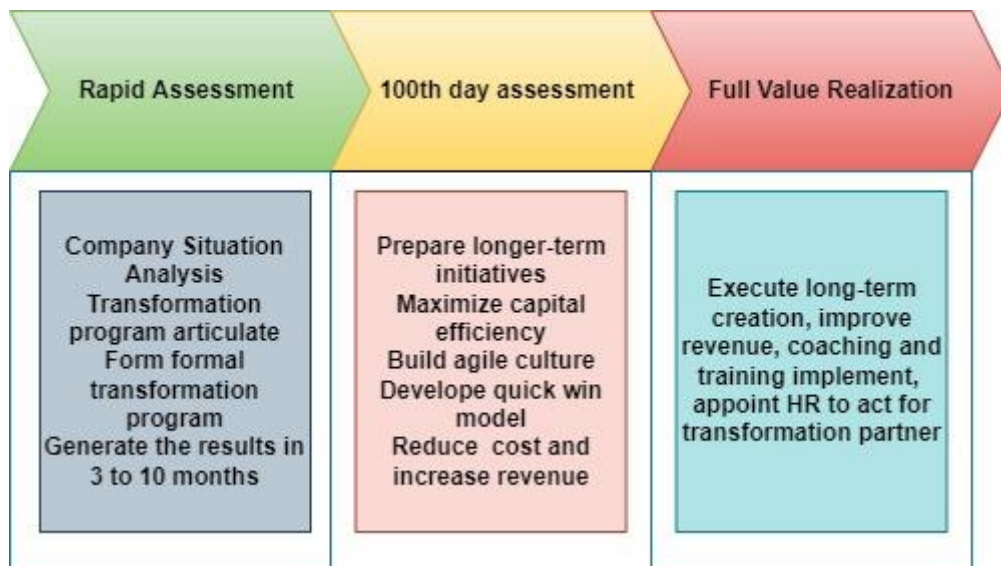


Figure 5: Graphical Representation of Winning Transformation Process

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

SMEs require effective policies and frameworks to adopt innovation model transformations that meet enterprise requirements. Pre-emptive organizational changes can lead to enterprise growth and profit. The growth of the agriculture sector is intricately intertwined with the complex and ever-evolving marketing environment, encompassing market trends, consumer preferences, competitive dynamics, and regulatory frameworks, all of which significantly shape the industry's development, sustainability, and profitability. Market trends reflect changing consumer demands, driving agricultural growth and influencing crop choices and farming techniques. Understanding consumer preferences is crucial for effective product positioning and market connections. Competitive dynamics require differentiation and value propositions, with factors like pricing, branding, and technology playing key roles. Regulatory frameworks impact practices, market access, and competitiveness, emphasizing compliance and promoting sustainability. Adapting to the marketing environment is essential for navigating the agriculture sector successfully. The use of the Matthew Correlation Coefficient (MCC) analysis in our study is based on its suitability for evaluating the performance of classification models in imbalanced datasets. The Pearson Correlation Coefficient, while widely used, has limitations in imbalanced scenarios when assessing predictive performance. It assumes linear relationships and may not capture nonlinear associations or perform well in complex and imbalanced datasets. In such cases, it can be influenced by the dominant class, leading to biased results and inadequate evaluation of minority or rare events.

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.

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

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.

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)

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

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

--	--	--	--	--	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.

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

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

367 $\Sigma(x - \bar{x})^2 = (78-81.4)^2+(65-81.4)^2+ \dots +(85-81.4)^2+(92-81.4)^2 = 437.2$

368

369 $\Sigma(y - \bar{y})^2 = (82-82.8)^2+(73-82.8)^2+ \dots +(84-82.8)^2+(90-82.8)^2 = 154.8$

370

371 $\Sigma(x - \bar{x})(y - \bar{y}) = (78-81.4)*(82-82.8)+(65-81.4)*(73-82.8)+ \dots +(85-81.4)*(84-82.8)+(92-$

372 $81.4)*(90-82.8) = 256.4$

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

$$S_{XY} = \frac{256.4}{5 - 1} = 64.1$$

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

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

Alternatively, $r = \frac{S_{XY}}{S_X S_Y}$

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

Test Calculations:

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

$$S = \sqrt{\left(\frac{1 - 0.9856^2}{5 - 2} \right)} = 0.09769$$

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

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

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

374 $p\text{-value} = 2 * \text{Min}(p, 1 - p) = 2 * \text{Min}(0.999, 0.001037) = 0.002074.$

375

376 According to the above computations, the probability value is equal to 0.002074, and it has
377 been defined as $P(x \leq 10.089) = 0.999$. 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

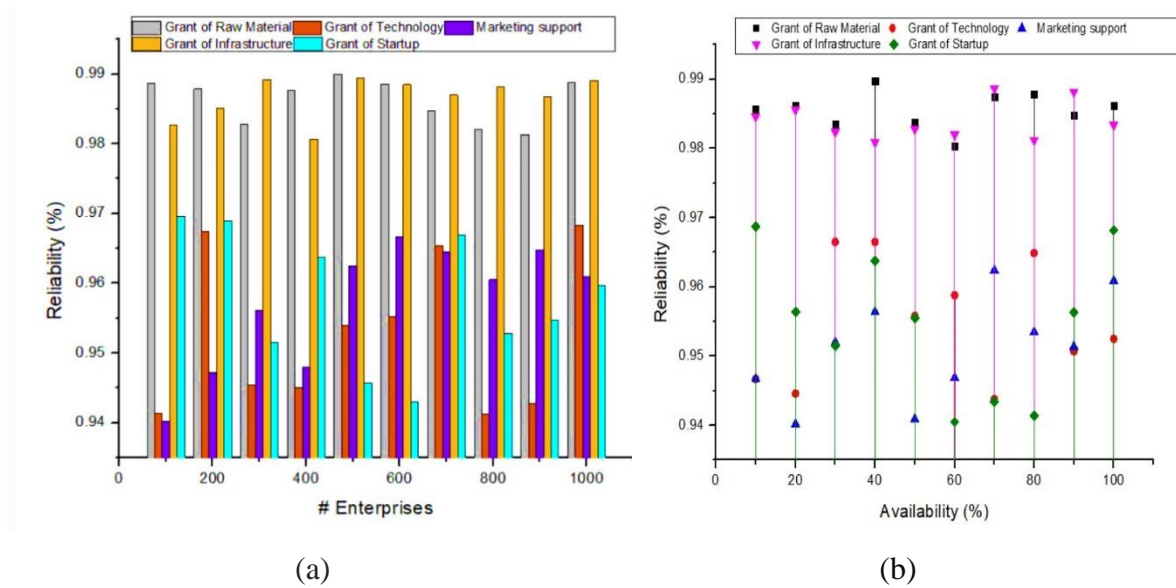


Figure 6: Reliability Analysis.

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

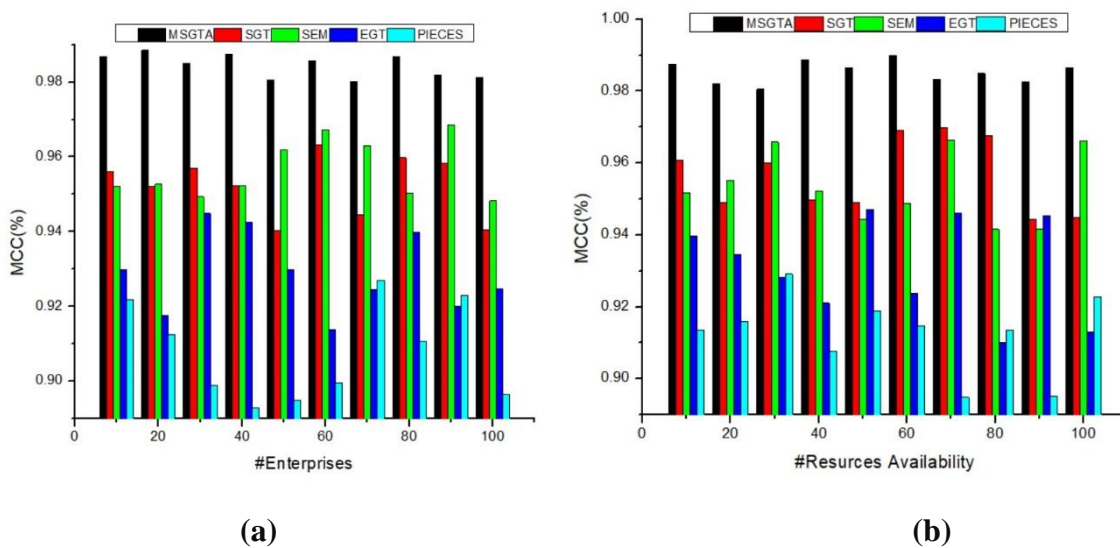
Table 4 demonstrates the internal consistency of SME employees, measured by analyzing a questionnaire. The Cronbach's Alpha value, ranging between 0 and 1, indicates the factors

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.

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

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

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.



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.

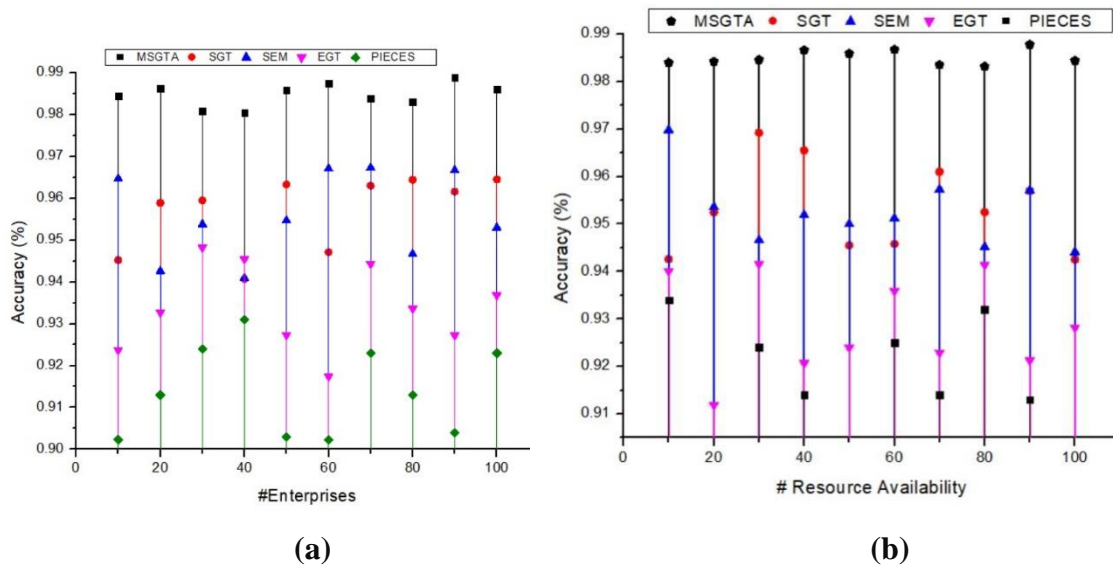


Figure 8: Accuracy Analysis (a) Enterprises and (b) Resource Availability.

Figure 8 clearly illustrates that the MSGTA approach achieves excellent performance with the highest accuracy rates of 98.3% for enterprises and 98.6% for resource availability. However, the obtained accuracy is relatively lower than other methods, such as SGT (0.95%, 0.956%), EGT (0.92%, 0.93%), SEM (0.92%, 0.953%), and PIECES (0.913%, 0.916%). Small and mid-sized enterprises can benefit from utilizing the Game-theoretic approach, specifically the Mixed Strategy Game-Theoretic Approach (MSGTA), to navigate pre-emptive changes and meet their enterprise growth requirements in a dynamic marketing environment [26-36]. A study utilizes game theory to analyze the competition between container port hubs, with a specific focus on Busan and Shanghai, offering valuable insights into their strategic dynamics [37]. Recent studies in China have examined the impact of the low-carbon strategy on digital transformation in manufacturing, developed stock intelligent investment strategies, explored the influence of group identity on bidding behavior, investigated innovation inequality, and analyzed the relationship between fintech, financial constraints, and outward foreign direct investment [38-42]. Additionally, researchers have assessed changes in CSR efficiency in the Chinese food industry due to the COVID-19 pandemic [43-44]. This study aims to optimize the design of a hybrid energy system using a modified-gray wolf algorithm, develop a project management strategy for urban flood disaster prevention, and propose a novel hybrid algorithm for efficient task scheduling in distributed systems [45-47].

4. Conclusion

The agriculture sector's growth is closely tied to the dynamic marketing environment, which includes market trends, consumer preferences, competition, and regulations. Market trends and

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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