American Journal of Engineering Research (AJER)
e-ISSN: 2320-0847 p-ISSN : 2320-0936
Volume-13, Issue-12, pp-88-101
www.ajer.org
Research Paper
Open Access

Four-Party Game Model-Based Investigation into Quality Supervision of Green Building Reports

Yinkai Wei [a] ,Wei Li[a] , Wudong Ban [a] ,Qi Zhang [b] ,Zhong diao Xie[c]
a.Shanxi Conservancy Vocational and Technical College, Yuncheng, Shanxi 044000;
b.Yuncheng Vocational and Technical University, Yuncheng, Shanxi 044000;
c.Jiangxi University of Science and Technology, Ganzhou, Jiangxi 341000

Abstract: *The pursuit of high-quality development in the construction industry and the national economy holds profound strategic significance. Quality supervision of research reports within the construction domain serves as a crucial safeguard for public safety and social stability. Grounded in the phenomenon of expert refutations, this study formulates an evolutionary game model involving the government, architectural research institutions, media platforms, and the public. The stability of strategic choices among the game players is dissected, and potential equilibrium points within the system are analyzed in accordance with Lyapunov's first theorem. Matlab 2021 is then employed to assess the impact of key factors on system evolution. The findings reveal that diminishing government incentive policies, enhancing the likelihood of expert rumor refutation, and bolstering the rational judgment of the public can curtail the occurrence of low-quality research reports on green building projects. Higher credibility values render construction research institutions and media platforms more disposed to furnish high-quality research and validation reports.*

Keywords: *Green building project research report; Quality supervision; Punishment mechanism; The rumor; Evolutionary game*

Date of Submission: 04-12-2024 Date of acceptance: 17-12-2024

I. INTRODUCTION

Since 1978, China's construction industry has thrived in the context of 40 years of reform and opening up. In 2017, the output value of the construction industry reached 213.944 billion yuan, accounting for 26% of the GDP in the same period, with a 10.5% increase compared to 2016, exceeding the growth rate of 6.9% in the same period [1]. The construction industry plays a significant role in the development of China's national economy. The high-quality development of the construction industry constitutes an essential part of the high-quality development of China's economy. Research on the high-quality development of the construction industry is of substantial significance for promoting the high-quality development of the national economy. Concurrently, based on China's 40-year development experience of reform and opening up, although remarkable achievements have been made in overall economic development, the issue of regional development imbalance is prominent. The same problem prevails in the development of the construction industry. Empirically, the development levels of the construction industry in the eastern, central, and western regions of China are unbalanced [2]. Thus, it is imperative to establish an effective measurement index system in the construction industry to assess the quality development levels of the construction industry at various provincial levels and re-evaluate the development quality of the construction industry.

In line with national policies in recent years, the construction industry represents a major innovation in the theory of sustainable economic development. To date, the definition of the construction industry economy remains inconsistent in academia. Meanwhile, scholars have yielded diverse research outcomes. The majority concur that the quality of economic growth and the quality of development are two crucial aspects of high-quality economic development. The term "high" accentuates the fundamentals of economic development, as well as new concepts and requirements of China's economic development in the new era.

Given the close association between the construction industry and China's economic development, the development quality of the construction industry will serve as a potent driving force for the high-quality development of China's economy [3]. Therefore, drawing on scholars' research regarding the connotations of

high-quality development, the level of high-quality development of the construction industry can also be appraised from the perspectives of "construction industry growth" and "construction industry quality" [4]. This represents an important material foundation for the high-quality development of the construction industry. According to previous research findings, the growth of the construction industry primarily encompasses two aspects: the scale growth of the construction industry and the stable growth of the construction industry. Under the new economic normal, the development resulting from the rapid expansion of the construction industry belongs to the past. The connotations of high-quality development of the construction industry in the new era should not only embrace the growth of the construction industry but also underscore the quality of development. Essentially, the "development quality of the construction industry" pertains to the extent to which the "inherent attributes" of the construction industry fulfill the requirements during the development process. Demand satisfaction is a multi-dimensional concept founded on the five development concepts and manifested as meeting the needs of innovative development, coordinated development, green development, open development, and shared development [5].

In this paper, we will comprehensively consider the evolution of group behaviors among the four game players of concern in the above literature: government regulatory authorities, media, the public, and architectural research institutions. Additionally, as the root cause of public opinion dissemination, the behavior evolution trend of public opinion generators and their impacts on the entire system merit investigation. The sources of architectural research reports are related organizations, which include architectural research institutions, building material manufacturers, upstream and downstream enterprises, and online and offline retailers [7]. On this basis, this study incorporates architectural research institutes as game subjects into the model, taking into account the reality of science popularization and the refutations of rumors regarding professional advantages between experts and NGOs. A four-way replicator dynamic evolutionary game model is constructed, with the intention of further exploring the impact of the decision-making mechanisms of game subjects on the quality of architectural research in the event of major security incidents [8-9].

II. Problem Description and Model Construction

II.1 Problem Elucidation

In the new era, certain entities capitalize on the panic psychology of the public and the susceptibility to induction. By releasing inappropriate research reports regarding green building projects, they prompt the public to engage in irrational behaviors, consequently leading to an adverse scenario of a continuous surge in housing prices. To address this issue, this study formulates a game model for the quality control mechanism of research reports on green building projects within the framework of high-quality development [10]. Prior to the issuance of a report, the government is obligated to conduct monitoring and assess its potential consequences. A feasibility study is carried out on the report. This paper focuses on three aspects: (1) In the context of highly developed social media, how can the likelihood of low-quality construction research reports be diminished? What measures can the government implement? (2) How can the public be guided to make rational identifications and curtail losses? (3) How do experts and non-governmental organizations possessing professional advantages in combating false information complement the supervision efforts of government regulatory departments? How do they impact the decision-making of construction organizations and media platforms? This paper constructs a multi-agent game model for the quality supervision of research reports on green building projects with government participation , and the logical interrelationships among the four game players are depicted in Figure 1.

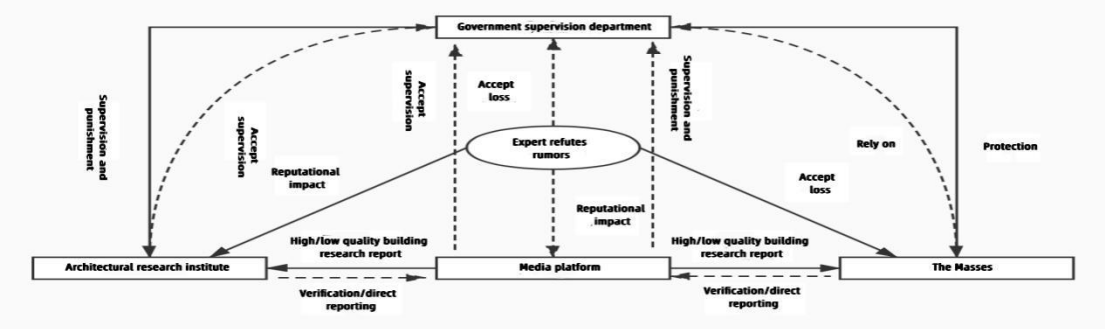


Figure 1. Logical relationship of the game model for quality supervision of multi-agent building research report

II.2 Model Construction

In the context of high-quality development, the following hypotheses are presented to direct the public opinion of stakeholders, formulate a game model, and explore strategies for standardizing the quality of online construction outcomes in light of public feedback [11].

Hypothesis 1: The key players in the game are government regulators, construction research institutions, media platforms, and the public. Construction research institutions release research findings. The probability of them issuing a high-quality report is p, and that of a low-quality report is 1 - p. These reports are then published on Internet-based media platforms. The media has a probability m of verifying the report and a probability 1 - m of directly reporting without verification. The public has a probability q of making a rational distinction and a probability 1 - q of believing the report without scrutiny. In large-scale development projects, the public is highly responsive to construction quality reports, which might trigger negative behaviors. Government regulators may decide to enforce strict regulations on research reports prior to their release, with a probability r, and the probability of loose regulation is 1 - r. All four entities are risk-neutral and strive to optimize their own interests.

Hypothesis 2: When construction research institutions obtain research results, they can reap benefits such as augmented sales revenue and enhanced brand recognition. Conducting high-quality research demands more resources. If government regulatory authorities conduct strict supervision, the pre-publication cost for the research institution is C_h. Since the revenue of media platforms is tied to the number of clicks, under high-quality circumstances, major media platforms actively report, and the associated revenues are $C_{h1}$and C_{h2}. The research exerts an influence on C, and rational discrimination involvesC_{g1}、C_{gh} and so on.

Hypothesis 3: High-quality architectural research imparts positive signals to the public and the government, yielding benefits B_p and B_g. In contrast, low-quality research transmits misleading information, leading to negative consequences N_p and N_g.

Hypothesis 4: In the context of high-quality development, if government regulators can assess the quality of research reports on green building projects before their release, gauge their social implications, and avert the dissemination of low-quality reports, the penalty standards C_m for construction research institutions and media platforms are F_h and F_m respectively. Hypothesis 5: After a low-quality research report on a green building project is published, if the public can make a rational judgment, the reputation of the construction research institution and the credibility of the media platform will deteriorate, incurring losses R_h. If the public blindly accepts the low-quality report, it will also have adverse effects. If experts and non-governmental organizations refute low-quality reports, it can mitigate the damage and have beneficial impacts on the public and the government. The game matrix for the quality of research reports on green building projects is illustrated in Table 1.

Table 1 A four-way game payment matrix for quality supervision of construction research coverage

Strategic choices		Media platforms	Government regulatory agency: Strictly regulated g — The public rationally discriminates with a probability of p	Strictly regulated g — The public directly believes with a probability of 1 - p	Loose regulation 1-g — The public directly believes with a probability of 1 - p	Loose regulation 1-g — The public rationally discriminates with a probability of p
Architectural Research Institute	High-quality green building project research report r	Report Verification m	Φ-C_{rh}, Ψ-C_{mh}, $_g$B-C_{gh}, $_p$B-C_p	Φ-C_{rh}, Ψ-C_{mh}, $_g$B -Cg_h, p	Φ-C_{rh}, Ψ-C_{mh}, $_g$B-C_{h1}, $_p$B-C_p	Φ-C_{rh}, Ψ-C_{mh}, B-C_{gg1}, p
		Direct Report 1-m	Φ-C_{rh}, Ψ-C_{m1}, $_g$B-C_{gh}, $_p$B-C_p	Φ-C_{rh}, Ψ-C_{m1}, B-C_{gh}, p	Φ-C_{rh}, Ψ-C_{m1}, $_g$B-C_{g1}, $_p$B-C_p	Φ-C_{rh}, Ψ-C_{m1}, B-C_{gg1}, p
	Research report on Low-quality green building projects 1-r	Report Verification m	-Cr1-C_{mh}, -Cr1-C 0,0	C_{r1}-C-C_{mh} 。 0,0	C_{r1}-C-C_{mh} 。 0,0	C_{r1}-C-C_{mh} 。 0,0
		Direct Report 1-m	C_{r1}-C-F_r, -C-F_{m1m},	C_{r1}-C-F_r, $_{m1}$-C-F_m,	C_{r1}-C-R_r, C_{m1}-C-R_m,	Φ-C_{r1}- βR_r。 Ψ - C_{m1} - βR_m。

$F_r + F_{m-} C_{gh}$。	$F_r + F_m - C_{gh}$。	$-C_{g1}, -C$	$C_{g1}-C - N_g + \beta T_g$。
0	0	p	$-N_p + \beta T_g$

III. Stability Analysis of the Strategy of Each Agent

3.1 Stability Analysis of the Report Quality Strategy of Architectural Research Institutions

The expected revenues of construction units in choosing to provide high-quality or low-quality architectural research, along with the replicator dynamic equation and the first-order derivative of the quality strategy, are as follows:

$$\begin{cases} U_r = \alpha(\phi - C_{rh}) \\ U_{1-r} = \alpha\{(1-m)(1-g)(1-p)\phi - C_{rl} - (1-m)gF_r - (1-m)(1-g)[p+(1-p)\beta]R_r\} \end{cases} \quad (1)$$

$$F(r) = \frac{\mathrm{d}r}{\mathrm{d}t} = r(U_r - \bar{U}) = \alpha r(1-r)\{[1-(1-m)\cdot(1-g)(1-p)]\phi + (1-m)(1-g)[p+(1-p)\beta]R_r + (1-m)gF_r - C_{rh} + C_{r1}\} \quad (2)$$

$$F'(r) = \alpha(1-2r)\{[1-(1-m)(1-g)(1-p)]\alpha + (1-m)(1-g)[p+(1-p)\beta]R_r + (1-m)gF_r - C_{rh} + C_{r1}\} \quad (3)$$

According to the stability theorem of differential equations, for the construction industry alliance to opt for publishing high-quality research reports on green building projects in a stable state, it is requisite that，F(r)=0andF'(r)<0。

Proposition 1: When $p>p_0$，the stable strategy of the construction industry alliance is to release high-quality research; when $p<p_0$，the stable strategy is to issue low-quality research; when $p=p_0$，the stable strategy remains indeterminate. Herein, the threshold value is $p_0 = C_{rh} - C_{r1}1/2[1 - (1-m)(1-g)\Phi - (1-m)gF_r - (1-m)(1-g)\beta R_r\}/[(1-m)(1-g)\Phi + 1/2(1-m)(1-\beta)R_r\}$。

Proof:$N(p)=2/3[1-(1-m)(1-g)(1-p)]\Phi+1/3(1-m)(1-g)[p+(1-p)\beta]R_r+1/2(1-m)gF_r-C_{rh}+C_{r1}$，and it is supposed that $\frac{\partial N(p)}{\partial p}>0$，Consequently, N(p) represents an increasing function with respect to p。When p>p0，N(p)>0，F(r)|r=1=0，$F'(r)|_{r=1}<0$，attains r=0 stability;When $p<p_0$，N(p)<0，$F(r)|_{r=0}=0$，$F'(r)|_{r=0}<0$，thus r=0 acquires stability;whenp = p_0, N(p) = 0, F(r) = 0 = 0and F' (r) = 0，then r∈[0,1]exists in a stable state and the stable strategy cannot be ascertained。

Proposition 1: posits that under high-quality development, if the public can rationally handle research reports on green building projects, discerning their scientific essence prior to taking actions rather than directly assuming the report to be incorrect, which would otherwise lead to unnecessary losses. In such a scenario, if the construction industry publishes low-quality research reports, it not only fails to procure the anticipated benefits but also incurs reputational damage. Based on

Proposition 1, the phase diagram of the quality strategy selection of the construction industry alliance for construction research is presented in Figure 2.

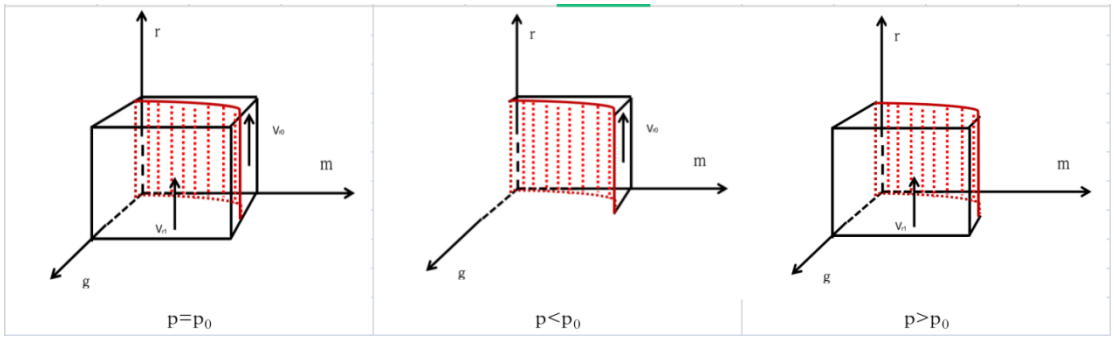


FIG. 2 Strategic selection stage diagram of construction industry alliance

In Figure 2, the volume of the V_{r1} segment represents the probability of the construction industry providing high-quality architectural research. Correspondingly, the V_{r0} represents the probability of the construction industry providing low-quality architectural research.

$$V_{r1} = \int_0^1 \int_0^1 \{1-(\phi+C_{r1}-c_{rh}/[(1-g)\phi - gF_r - (1-g)\beta R_r - (1-g)[\phi+(1-\beta)R_r]p\}dpdr = 1 - \frac{\phi + C_{r1} - C_{rh}}{(1-g)[\phi+(1-\beta)R_r} \cdot ln\frac{gF_r + (1-g)\beta R_r - (1-g)\phi}{gF_r + (1-g)R_r} \quad (4)$$

$$V_{r0} = 1 - V_{r1} = \frac{\phi + C_{r1} - C_{rh}}{(1-g)[\phi+(1-\beta)R_r} \cdot ln\frac{gF_r + (1-g)\beta R_r - (1-g)\phi}{gF_r + (1-g)R_r} \quad (5)$$

Inference 1: The terminal stable strategy of the construction industry alliance within the context of the research on the quality supervision of green building reports under the quadripartite game model involves the establishment of a quality control regime for research reports concerning green building projects, the enhancement of the public's rational decision-making tendencies, and the release of high-quality research reports on green building projects .

Corollary1： indicates that during the progression of the research on quality supervision, in the absence of sufficient relevant information regarding green building projects, the public is liable to experience panic and is susceptible to the influence of online disclosures. They adhere to the principles of "presence being preferable to absence" and "more being better than less", thereby neglecting the government's appeals for "moderation". The government advocates the concepts of "public participation being beneficial", "a greater quantity being advantageous", and "moderation being optimal". This implies that the government is duty-bound to supervise and assess construction reports within the framework of this research. Simultaneously, it is essential for the government to strengthen the public's rational judgment capabilities and to encourage rational individuals to persuade and refute rumors on behalf of their irrational acquaintances. A punitive mechanism should be established for actions that cause adverse effects during the process of quality supervision of green building reports, thereby warning relevant construction enterprises that the digital domain is not a lawless area and that this research period does not present an opportunity for construction enterprises to amass financial gains. If the public maintains a skeptical attitude towards traces of rationality and then rationally considers the advice provided by experts and relevant non-governmental organizations, the government regulatory body can effectively implement the punitive mechanism and successfully prevent the construction industry alliance from issuing substandard research reports on green building projects and luring public consumption [12].

3.2 Stability Analysis of the Report Quality Strategy of Media Platforms

Media platforms choose between verification reports or direct reports for expected revenues. The replicator dynamic equation and the first-order derivative of the verification strategy are as follows:

$$\begin{cases} U_m = \alpha(\gamma\psi - C_{mh}) \\ U_{1-m} = \alpha\{[r+(1-r)(1-g)(1-p)]\psi - (1-r)(1-g)[p+(1-p)\beta]R_m - (1-r)gF_m - C_{m1}\} \end{cases} \tag{6}$$

$$F(m) = \frac{\mathrm{d}m}{\mathrm{d}t} = m(U_m - \bar{U}) = \alpha m(1-m)\{[(1-r)\cdot(1-g)[p+(1-p)\beta]R_m + (1-r)gF_m - (1-r)(1-g)(1-p)\psi - C_{mh} + C_{m1}\}) \tag{7}$$

$$F'(m) = \alpha(1-2m)\{(1-r)(1-g)[p+(1-p)\beta]R_m + (1-r)gF_m - (1-r)(1-g)(1-p)\psi\} - C_{mh} + C_{m1}\} \tag{8}$$

According to the stability theorem of differential equations, if f(m)=0 且 F'(m)<0， then the media strategy is required to be in a stable state。

Proposition 2：When $g>g_0$， the stable strategy of the media platform is to conduct report verification and prudently release information capable of guiding public opinion; when $g<g_0$，its stable strategy is to report directly; when g=g 时 $_0$，the stable strategy remains indeterminate，Here, the threshold ,g_0=2/3[C_{mh}-C_{m1}+(1-r)(1-p)Ψ - (1-r)[p+(1-p)β]R_m][(1-r)(1-p)Ψ + 1/3(1-r)F_m- (1-r)[p+(1-p)β]R_m] $^{-1}$。

Proof: Let T(g)=1/2(1-r)(1-g)[p+(1-p)β]R_m+(1-r)gF_m-(1-r)(1-g)Ψ+1/3C_{m1}-1/3 C_{mh}，and assume $\frac{\partial H(g)}{\partial g}$>0，Consequently, T(g)is an increasing function of g.Since $g<g_0$，H(g)<0，$F(m)|_{m=0}$=0 and F′(m)$|_{m=0}$=0，then m=0 attains stability; ；When $g_0>g$，H(g)>0，$F(m)|_{m=1}$=0 and F′(m)$|_{m=1}$<0，then m=1acquires stability；when $g=g_0$，H(g)=0，F(m)=0 and F'(m)=0，then m∈[0,1]exists in a stable state and the stable strategy cannot be determined.

Proposition 2:implies that an augmentation in the probability of strict supervision by the government regulatory department will lead to the transformation of the media platform's stable strategy from direct reporting to verification reporting; likewise, an alteration in the probability of strict control and supervision by the government regulatory department will result in the conversion of the media platform's stable strategy from verification reporting to direct reporting. It is evident that in order to avert substantial social losses, it is essential for the government regulatory department to adopt measures concerning the release of construction research reports during the process of high-quality development [13].

Based on Proposition 2, the phase diagram of the verification strategy of the media platform for the quality of architectural research reports is illustrated in Figure 3.

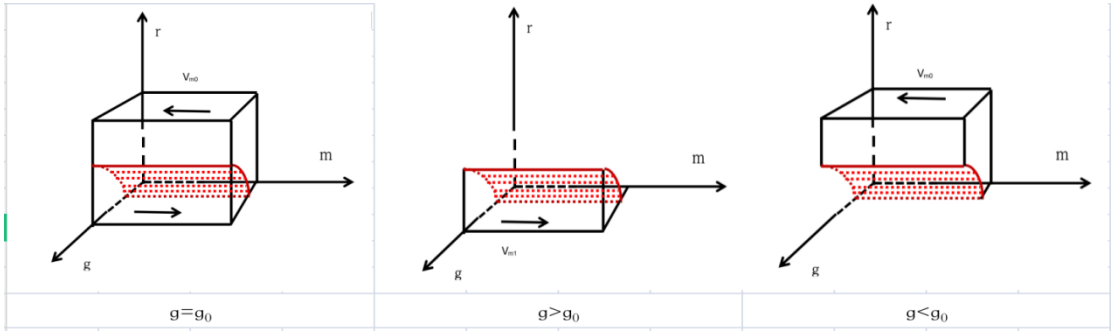


Figure 3 Stage diagram of media platform validation policy selection

In Figure 3, V_{m1}represents the probability of the media platform performing verification reporting, and correspondingly, V_{m0}represents the probability of the media platform making a direct report.

$$V_{m1}=\int_0^1\int_0^{1-\frac{1}{2}\frac{C_{mh}-C_{m1}}{F_m}}[(1-r)F_m-C_{mh}+C_{m1}/\{(1-r)(1-p)\psi+(1-r)F_m-(1-r)[p+(1+p)\beta]R_m drdm\}=\frac{1}{2}\frac{F_m-C_{mh}+C_{m1}+(C_{mh}-C_{m1})ln(C_{mh}-C_{m1})/F_m}{(1-p)\psi+F_m-[p+(1-p)\beta]R_m} \quad (9)$$

$$1-\frac{1}{2}\frac{F_m-C_{mh}+C_{m1}+(C_{mh}-C_{m1})ln(C_{mh}-C_{m1})/F_m}{(1-p)\psi+F_m-[P+(1-p)\beta]R_m} \quad (10)$$

Inference 1: When a platform has a significantly high reputational value, with the increase in government-imposed penalties and the loss of reputation, the media platform will increase the probability of performing verification reports.

Corollary 2：indicates that when the platform's reputational value is rather high, the verification probability of the media platform for research reports on green building projects has an inverse relationship with the amount of government penalties and the loss of reputation. For media platforms that report low-quality research reports on green building projects during special periods and lead to events like panic buying, a stronger government penalty can effectively boost the verification probability before reporting. For this purpose, the government regulatory department can set up an effective penalty mechanism to urge the media platform to verify its reports. As the loss of public credibility increases, the probability of the media platform's verification reporting significantly rises. The public credibility of a media platform with relatively high authority can provide the public with authoritative media reports [14].

3.3 Stability Analysis of the Regulatory Strategy of Government Regulatory Agencies

The expected revenues, replicator dynamic equation and first-order derivative strategy under strict or lenient government department regulation：

$$\begin{cases}U_g=\frac{2}{3}\alpha[r(B_g-C_{gh}+(1-r)(1-m)(F_r+F_m-C_{gh})]\\U_{1-g}=\frac{1}{3}\alpha[r(B_g-C_{g1})-(1-r)(1-m)C_{g1}+(1-r)(1-m)(1-p)(\beta T_g-N_g)\end{cases} \quad (11)$$

$$F_g=\frac{dg}{dt}=\frac{2}{3}g(U_g-\bar{U})=\frac{2}{3}\alpha g(1-g)\{[r+(1-r)(1-m)](C_{g1}-C_{gh}+(1-r)(1-m)[F_r+F_m+(1-p)(N_g-\beta T_g]\} \quad (12)$$

$$F_g^{'}=\frac{2}{3}\alpha(1-2g)\{[r+(1-r)(1-m)](c_{g1}-c_{gh}+(1-r)(1-m)[F_r+F_m+(1-p)(N_g+\beta T_g]\} \quad (13)$$

Stability Analysis of the Regulatory Strategy of Government Regulatory Agencies In accordance with the stability theorem of differential equations, for the media to opt for publishing high-quality architectural research reports, it must be in a stable state fulfilling the following conditions: F(g) = 0andF'(g) < 0。

Proposition 3: Whenp<p_1，the stable strategy of the government regulatory department is strict regulation; when p>p_1，the stable strategy of the government regulatory department is lenient regulation; when p=p_1， the stable strategy of the government regulatory department remains indeterminate. Here, the threshold p_1=1-2/3{[r+（1-r）（1-m）]（C_{gh}-C_{g1}）_1/3（1-r）（1-m）（F_m-F_r)}[（1-r）（1-m）（N_g-βT_g] $^{-1}$

Proof: Let K(p)=2/3[r +(1-r)(1-m)(C_{g1}-C_{gh})+1/3(1-r)(1-m)[F_r+F_m+(1-p)(Ng-βT_g)]。 Assume ,$\frac{\partial K(p)}{\partial p}$<0 ,K(p)is a decreasing function of p。当 p<p1，K(p)>0，F(g)|$_{g=1}$=0 和 F′(g)|$_{g=1}$<0，theng=1possess stability；When p>p_1，Since ,K(p)<0，F(g)|$_{g=0}$=0and F′(g)|$_{g=0}$<0，g=0 attains a stable state; when p=p_1，K(p)=0，F(p)=0 and F'(p)=0，g∈[0,1]then \(g\in[0,1]\) exists in a stable state and the stable strategy cannot be determined.

Proposition 3: asserts that during the development process, when the public makes a rational judgment regarding the improvement probability of construction research reports, the stable strategy of the government regulatory department shifts from regulation to lenient regulation. That is, if people possess a high capacity to identify news, they can assess whether the quality of construction research reports is high or low, thereby avoiding serious social harm. At this juncture, the government regulatory department can curtail regulatory costs, and the stable strategy is lenient regulation [15]. Conversely, if the public has a high ability to identify news, the

government regulatory department can save on regulatory costs, and the stable strategy is to relax regulation. Based on Proposition 3, the phase diagram of the regulatory strategy selection of the government regulatory agency is depicted in Figure 4.

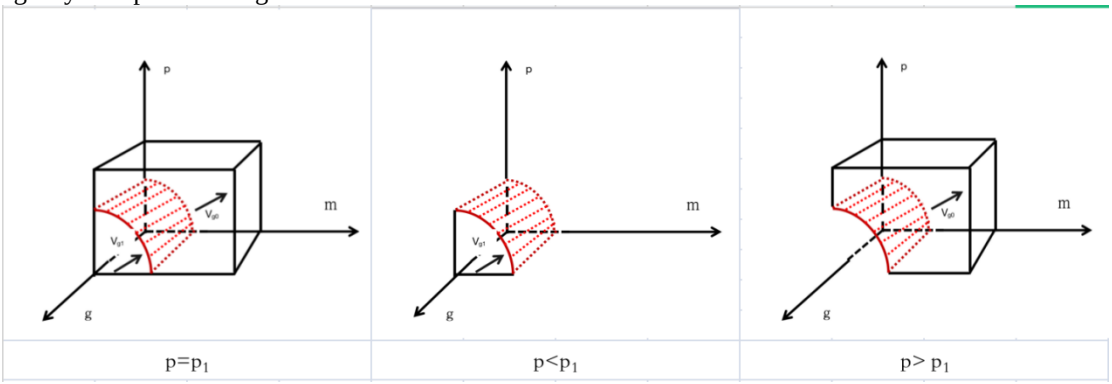


Figure 4. Stage diagram of regulatory strategy selection by government regulators

In Figure 4， V_{g1} represents the probability of strict supervision by the government regulatory department. Correspondingly,V_{g0}represents the probability of lenient supervision by the government regulatory department. Thus, $u=1-r(C_{gh}-C_{g1})[(1-r)(N_g-\beta T_g-C_{gh}+C_{g1}-F_m-F_r]^{-1}$， The calculation yields:

$$V_{g1}=\frac{3}{4}\int_0^1\int_0^{\frac{5}{3}}\{1-[r+(1-r)(1-m)](C_{gh}-C_{g1}+(1-r)(1-m)(F_m+F_r)(1-r)(1-m)(N_g-\beta T_g]^{-1}\}dmdg=1-\frac{5}{4}\{(1-r)(F_m+F_r)+C_{gh}-C_{g1}-\frac{2}{3}r(C_{gh}-C_{g1})ln[r(C_{gh}-C_{g1})(1-r)^{-1}(N_g-\beta T_g-C_{gh}-C_{g1}-F_m-F_r)^{-1}]\}[(1-r)(N_g-\beta T_g]^{-1} \quad (14)$$

$$V_{g0}=1-V_{g1}=1-\frac{3}{5}\{(1-r)(F_m-F_r)+C_{gh}-C_{g1}-r(C_{gh}-C_{g1})ln[r(C_{gh}-C_{g1})(1-r)^{-1}(N_g-\beta T_g-C_{gh}+C_{g1}-F_m-F_r^{-1}\}[(1-r)(N_g-\beta T_g^{-1} \quad (15)$$

Inference 3: In the process of high-quality development, with the augmentation of the social damage resulting from low-quality research reports on green building projects, the optimal strategy for government regulators is to enhance the probability of strict supervision.

Corollary 3: reveals that the probability of strict supervision of construction research reports by regulatory departments is positively correlated with social losses. Relevant construction research reports are intimately associated with the interests of the public and society. For research reports that are anticipated to cause severe social disruptions, government departments in charge ought to carry out reporting, prediction, and verification, and stringently supervise reports with substantial social impacts, implementing early prevention and early resolution.

3.4 Stability Analysis of the Masses' Reporting Handling Strategy

The expected revenues of the masses' rational discrimination or direct belief, the replicator dynamic equation and the first-order derivative of the reporting handling strategy:

$$\begin{cases} U_p = \frac{2}{5}\alpha[r(B_r - C_r) - (1-r)(1-m)(1-g)C_p \\ U_{1-p} = \frac{3}{5}\alpha[rB_p - (1-r)(1-m)(1-g)(N_p - \beta T_p) \end{cases} \quad (16)$$

$$F_p = \frac{dp}{dt} = \frac{2}{5}p(U_p - \bar{U}) = \frac{2}{5}\alpha p(1-p)[(1-r)\cdot(1-m)(1-g)(N_p - \beta T_g - C_p) - rC_p \quad (17)$$

$$F'(p) = \frac{2}{5}\alpha(1-2p)[(1-r)(1-m)(1-p)\cdot(N_p - \beta T_p - C_p) - \beta C_p] \quad (18)$$

Proposition 4: When $m<m_0$， the stable strategy of the masses is rational discrimination; when $m>m_0$， the stable strategy of the masses is direct belief; when$m=m_0$，the stable strategy of the masses remains indeterminate. Here, the threshold $m_0=1-2/3rC_p[(1-r)(1-m)(1-g)(N-\beta T_{pp}-C_p)]^{-1}$

Proof: Let $L(m)=2/5(1-m)(1-r)(1-g)(N_p-\beta T_g-C_p)$， and assume $\frac{\partial L(m)}{\partial m}<0$， Consequently， L(m) is a decreasing function of m。When $m<m_0$，$L(m)>0$，Since $F(p)|_{p=1}=0$ and $F'(p)|_{p=1}<0$， Given tha p=1acquires stability; when $m>m_0$，$L(m)<0$，$F(p)|_{p=0}=0$ and $F'(p)|_{p=0}<0$，then p=0 acquires stability; when $m=m_0$，$L(m)=0$，$F(p)=0$and $F'(p)=0$ 时， thenp∈[0,1]exists in a stable state and the stable strategy cannot be determined.

Proposition 4:implies that a high-probability verification report established by the media platform will cause the masses to transform from a stable strategy of rational judgment to direct belief. Because the media platform has set up a high-probability verification report, it screens out low-quality constructions for the masses. The reports of researchers on mass media platforms enhance trust and save costs, and the final strategy stabilizes on the media platform. Conversely, if a media platform has a high probability of direct reporting and frequently publishes low-quality research reports, it will lose the trust of the masses, and its strategy will shift from direct belief to rational judgment .

Based on Proposition 4, the phase diagram of the selection of mass media reception strategies is illustrated in Figure 5.

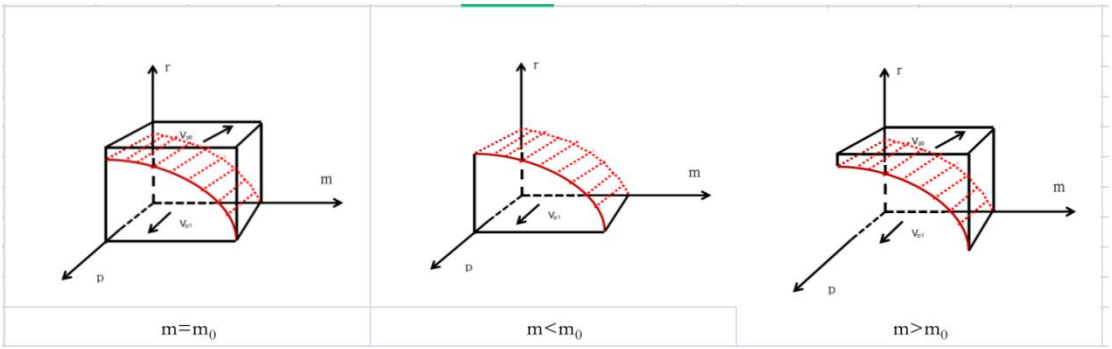


FIG. 5 Stage diagram of mass media strategy selection

In Figure 5， V_{p1}represents the probability of the masses rationally discriminating among the research reports on green building projects. Correspondingly,V_{p0}represents the probability of the masses choosing to completely believe these reports. Let v = (1-g)(N -βT $_{pp}$-C $_{p}$)[1-g)(N $_{p}$-βT $_{p}$-C $_{p}$) + C $_{p}$] $^{-1}$， he result can be obtained through calculation:

$$V_{p1}=\int_0^1\int_0^v[1-\frac{1}{3}\frac{rC_p}{(1-r)(1-g)(N_p-\beta T_p-C_p)}drdp]=1-\frac{1}{3}\frac{C_p}{(1-g)(N_p-\beta T_p-C_p)}ln\frac{(1-g)(N_p-\beta T_p+C_p)}{C_p} \quad (19)$$

$$V_{p0}=1-V_{p1}=1-\frac{1}{3}\frac{C_p}{(1-g)(N_p-\beta T_p-C_p)}\cdot ln\frac{(1-g)(N_p-\beta T_p+C_p)}{C_p} \quad (20)$$

Inference 4: When experts and non-governmental organizations with professional advantages are more inclined to refute rumors, the probability of the masses making rational judgments will decrease; when losses increase, the probability of the masses making rational judgments will increase.

Corollary 4: indicates that the probability of people's rational judgment in relation to architectural research is inversely related to the rumor-refuting rate of experts and non-governmental organizations with professional advantages and directly related to the damage caused. In the process of high-quality development, experts and non-governmental organizations with professional advantages can cause damage to the reputations of industry alliances and media platforms. Therefore, when such experts and non-governmental organizations are more likely to refute rumors, people will tend to directly believe them after high-quality construction research reports are published and then verified by media platforms. People should have a basic understanding of the severity of the matter, whether it is a false report or a deception, and make a basic assessment of the expected benefits and losses. When the expected loss is significant, they should maintain rational thinking to avoid larger losses.

IV. Stability Analysis of Strategic Combinations

In line with the first law of Lyapunov's quadrangular game, within the dynamic system of the quadrangular game involving the government regulatory department, architectural research institutions, media platforms, and the public, pursuant to Lyapunov's first law, the stable solution of the quadrangular game can be identified as a strict Nash equilibrium. Consequently, this paper will analyze the stability of the 16 pure strategy equilibria in the quadrangular evolutionary game to acquire the strict Nash equilibrium. Proceeding from the replicator dynamics equations of the game participants, the Jacobian matrix of the replicator dynamics system can be derived.

$$J=\begin{bmatrix}\frac{\partial F(x)}{\partial r} & \frac{\partial F(x)}{\partial m} & \frac{\partial F(x)}{\partial g} & \frac{\partial F(x)}{\partial p}\\ \frac{\partial F(x)}{\partial r} & \frac{\partial F(x)}{\partial m} & \frac{\partial F(x)}{\partial g} & \frac{\partial F(x)}{\partial p}\\ \frac{\partial F(x)}{\partial r} & \frac{\partial F(x)}{\partial m} & \frac{\partial F(x)}{\partial g} & \frac{\partial F(x)}{\partial p}\\ \frac{\partial F(x)}{\partial r} & \frac{\partial F(x)}{\partial m} & \frac{\partial F(x)}{\partial g} & \frac{\partial F(x)}{\partial p}\end{bmatrix} \quad (21)$$

4.1 Stability Analysis of Strategic Combinations under Lenient Government Regulation

When the stable strategy of the government regulatory agency is lenient regulation, that is, when the condition①1/5[r+(1-r)(1-m)](C$_{g1}$ -C $_{gh}$)+(1-r)(1-m)[F$_{r}$ +F $_{m}$+2/5(1-p)(N$_{p}$ -βT$_{g}$)] < 0， is met, the analysis of the asymptotic stability of the equilibrium points of the replicator dynamic system is shown in Table 2.

Table 2 Asymptotic stability analysis of equilibrium point replication of dynamic system under loose government supervision

Equilibrium point	Eigenvalueλ_1, λ_2, λ_3, λ_4	Positive and negative signs	Stability
(0,0,0,0)	1/3α(βR $_{r}$+C $_{rl}$-C $_{rh}$),1/3α(βR $_{m}$+C $_{ml}$-C $_{mh}$-ψ),1/3α(F $_{r}$+F $_{m}$+N $_{g}$+C -βT $_{glg}$-C $_{gh}$)	(F,-,-F)	When subparagraph (a) is satisfied， ESS

	1/3α(N p-βT p-C p)		
(1,0,0,0)	2/5α(C rh-βR r-Crl),3/5α(C ml-Cmh),α(Cgl -Cgh),-αC p	(F,-,-,-)	When subparagraph (b) is satisfiedESS
(0,1,0,0)	3/4α(φ+C rl-C rh),α(+C mh-βR m-C ml),0,1	(+,F,0,0)	instability
(0,0,0,1)	1/4α(φ+R +mC m1-C) ,mh3/4α(R m+C ml-C mh),1/5α(F r+F m+C gl-C gh),α(βT p+C p-N p)	(+,+,+,F)	×
(1,1,0,0)	1/3α(C -Φ-Crhr1),1/3α(Cml -C mh),α(C gl-C gh), -1/3αC p	(-,+,-,+)	instability
(1,0,0,1)	2/5α(C rh-Rr -Crl),1/5α(Cm -Cmh),1/5a(Cgl-Cgb),-αC p	(-,-,-,+)	instability
(0,1,0,1)	α(φ+Cr1 -C rh),α(C mh-R m-Cml),0,0	(+,-,0,0)	instability
(1,1,0,1)	1/6α(C rh-C) ,rl1/2α(C mh-C),1/ml3α(C gl-C gh),-αC p	(-,+,-,+)	instability

It can be observed from Table 2 that there are two stable strategies in the case of regulatory agencies' deregulation: (0, 0, 0, 0) and (1, 0, 0, 0). Among them, (1, 0, 0, 0) represents a high-quality public research report on construction projects. The media platform is selected for direct reporting to save verification costs. The government regulatory department implements lenient regulation to cut costs, making people directly believe that under this strategy, cost reduction and savings are the most effective. However, an inconsistency can be found between the result of the replicator dynamics analysis in (1, 0, 0, 0) and that in 3.1. The stable strategies of the government regulatory department, the media platform and the public are not conducive to promoting the provision of high-quality construction research reports as a stable strategy. After further analysis, it is discovered that the following conditions need to be satisfied when reaching the stable state of (1, 0, 0, 0): ： $\beta R_r > C_{rh} - C_{r1}$, When the probability that experts and non-governmental organizations with professional advantages refute rumors is rather high, the anticipated reputational loss of the construction industry alliance surpasses the cost savings achieved by furnishing low-quality research reports on green building projects. Consequently, they actively conduct comprehensive scientific research and supply high-quality research reports on green building projects. With the decline in the rumor-refuting rate of experts and non-governmental organizations with professional advantages, the replicator dynamic system will veer away from the optimal state of (1, 0, 0, 0).

When the system attains the state where $N_p - C_p$ ）$/T_p < \beta$（$Cr_h - C_{r1}$）$/R_r$, it will stabilize（0,0,0,0）The construction industry alliance issues low-quality research reports, the media platform directly reports the news, and the public will directly believe them and be led into actions that are disadvantageous to themselves, thereby exacerbating the chaotic circumstances. We ought to fully utilize the functions of relevant experts and non-governmental organizations with professional advantages to refute rumors and disseminate scientific knowledge, and preclude (0, 0, 0, 0)rom evolving into a stable equilibrium. During special times, the inadequate supervision of the government regulatory department is unfavorable for creating a congenial architectural news milieu. To avert low-quality research reports on green building projects from transforming into a stable strategy and to encourage non-governmental organizations with professional capabilities to refute rumors, the government regulatory department can institute incentive policies. When the refutation rate of experts and non-governmental organizations with professional capabilities exceeds a certain threshold, incentive policies can be adopted to render high-quality research reports on green building projects a stable strategy for the construction industry alliance.

4.2 Stability Analysis of Strategic Combinations under Strict Government Regulation

When the stable strategy adopted by the government regulatory body is strict supervision, namely, when the condition②$2/5[r + (1-r)(1-m)](C_{g1}-C_{gh}) + 3/5(1-r)(1-m)[F_r+F_m+ (1-p)(N_p-\beta T_g)] > 0$ holds, the analysis of the asymptotic stability of the equilibrium points within the replicator dynamic system is shown in Table 3.

Table 3 Asymptotic stability analysis of equilibrium points of replicated dynamic systems under strict government supervision

Equilibrium poin	特征值 $\lambda_1,\lambda_2,\lambda_3,\lambda_4$	Positive and negative signs	Stability
(0,0,1,0)	1/2α(φ+F r+C r1-C rh),1/3α(F m+C ml-C mh),1/3α(C gh+βT g-F r-F m-N g-C gl) ,0	(+,+,F,0)	instability
(1,0,1,0)	2/3α(C -φ-Frhr -Cr1),1/3α(Cml -Cmh),3/4α(Cgh -Cgl),-1/4αC p	(-,-,+,-)	×

(0,1,1,0)	$\alpha(\varphi+C_{r1}-C_{rh}),\alpha(C_{ml}-F_m-C_{ml}),0,0$	(+,-,0,0)	instability
(0,0,1,1)	$2/5\alpha(\varphi+F_r+C_{r1}-C),_{rh}1/5\alpha(F_m+C_{ml}-C_{mh}),1/5\alpha(C_{gh}-C-_gF_r-F_m),0$	(+,+,-,0)	instability
(1,1,1,0)	$1/3\alpha(C-\varphi-C_{rhrl}),1/4\alpha(C_{mh}-C_{ml}),1/2\alpha(C_{gh}-C_{gl}),-1/3\alpha C_p$	(-,+,+,-)	×
(1,0,1,1)	$1/6\alpha(C-\varphi-F_{rhr}-C_{rl}),1/2\alpha(C_{ml}-C_{mh}),1/3\alpha(C_{gh}-C_{gl}),1/3\alpha C_p$	(-,-,+,+)	×
(0,1,1,1)	$1/5\alpha(\varphi+C_{r1}-C),_{rh}4/5\alpha(C_{mh}-F_m-C_{ml}),0,0$	(+,-,0,0)	instability
(1,1,1,1)	$1/4\alpha(C-\varphi-C_{rhrl}),1/4\alpha(C_{mh}-C)_{ml},1/2\alpha(C_{gh}-C_{gl}),\alpha C_p$	(-,+,+,+)	×

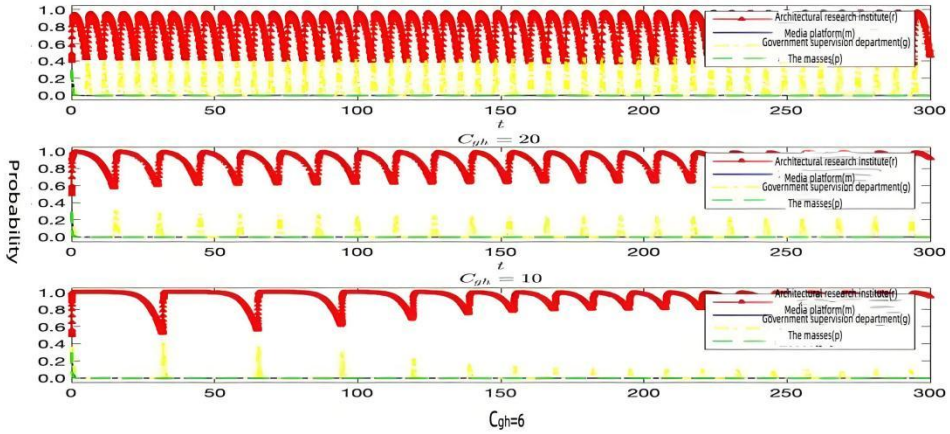
It can be discerned from Table 3 that in the context of strict government regulation, there exists no equilibrium point with a stable pure strategy. Based on the symbolic traits of the system equilibrium point (1, 0, 1, 0), it is evident that if the strict supervision strategy of the government regulatory department is stable, it implies the release of high-quality construction research reports, and the stable strategy of the media platform is direct reporting. At this juncture, the network environment is sound and can be directly trusted. Nevertheless, the strictly stable strategy of the government regulatory department is not truly stable. This circumstance aligns with the prior analysis of the stability of the supervision strategy of the government regulatory agency. Given that the construction industry can deliberately augment investment and issue high-quality research reports on green building projects, the government regulatory agency can enforce lenient supervision, thereby economizing on supervision costs. One of the revelations is that if the public interest is to be protected over the long haul and the construction industry is to spontaneously release high-quality research reports on green building projects, the government regulatory department must incur the supervision cost. Concurrently, the regulatory department ought to stringently supervise the research reports on green building projects to effectively preclude low-quality ones, which represents a progressively stabilizing strategy. In the simulation analysis section, by implementing effective supervision and punishment mechanisms, the replicator dynamic system of high-quality research reports on green building projects is steered clear of the impairment to the public environment and directed towards fostering a propitious social environment through high-quality research reports on green building projects, which will be further dissected in the simulation analysis section.

V. Simulation analysis

This article employs MATLAB 2021 to carry out numerical simulations of the evolutionary trajectories of all parties engaged in the game. The aim is to more vividly depict the impact of diverse elements within the replicator dynamics system on the evolutionary process of the multi-party game. In the context of a significant high-quality development, an architectural research institution may promptly proclaim the efficacy of research on relevant anti-epidemic drugs following cursory test-tube experiments. The cost associated with this research is $C_{r1}=4$； Alternatively, it can opt to pursue more in-depth research until a conclusive outcome is attained, with the cost of such research being $C_{rh}=15$， and the research is expected to yield $\Phi=20$。 media undertakes to report the research, the cost of verification reporting amounts to$C_{mh}=5$， while the cost of direct reporting without verification is $C_{m1}=2$，and the revenue accruing to the media platform from the report is $\Phi=15$。The cost entailed by strict government supervision is $C_{gh}=8$， and that of lax supervision is $C_{g1}=2$， low-quality research is $F_r=15$， $F_m=8$。 probability of the report being embraced by the public is $\alpha=0.65$， and the cost of rational judgment is $C_p=15$。 In the case of low-quality research reports, the rationally discerning public will not place their trust in them and will harbour doubts regarding the relevant architectural research institution and media platform, leading to reputation losses of $R_r=20$， $R_m=15$； respectively. Both the public and society will refrain from believing low-quality research reports on green building projects and will be skeptical of the relevant architectural research institution and media platform. Subsequent to low-quality research reports on green building projects, the probability of experts and non-governmental organizations with professional advantages refuting false information is $\beta=0.35$， and the losses recuperated for the public and society are $T_p=5$， $T=10$ respectively. The initial strategy selection range of each party in the game is$r=0.6$， $m=0.35$， $g=0.25$， $p=0.3$。

5.1 Cost impact of strict government regulation

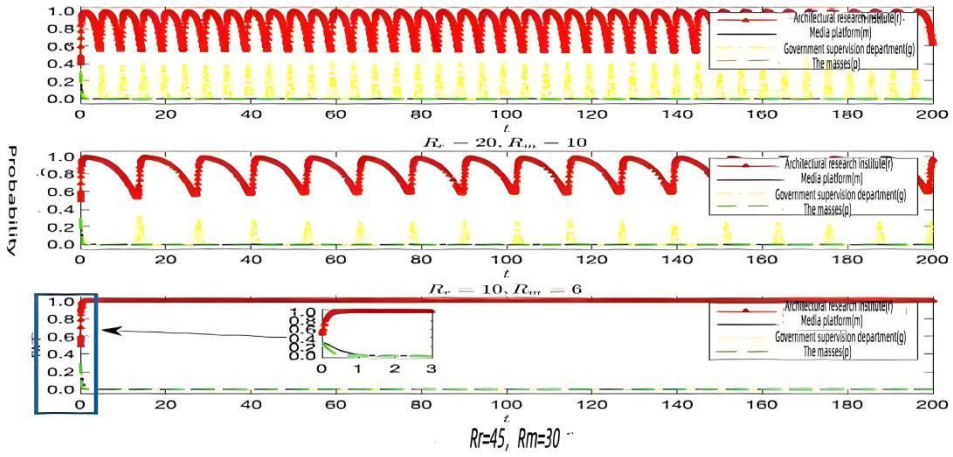
Assuming $C_{gh}=\{20,10,6,4\}$, the strategy evolution process and results of the four-party game players are shown in Figure 6.



It can be discerned from Figure 6 that the cost of strict government supervision impacts not only the strategic evolution trend of the government department but also those of the other three parties, with the architectural research institution being particularly affected. As the cost of strict government supervision by the regulatory department diminishes, the likelihood of the architectural research institution engaging in high-quality architectural research escalates considerably and attains stability in the pure strategy of furnishing high-quality research reports over a prolonged duration. Hence, by curtailing the cost of strict supervision, the generation of high-quality research reports on green building projects by the architectural research institution can be spurred.

5.2 Impact of loss of reputation value caused by feedback from the masses

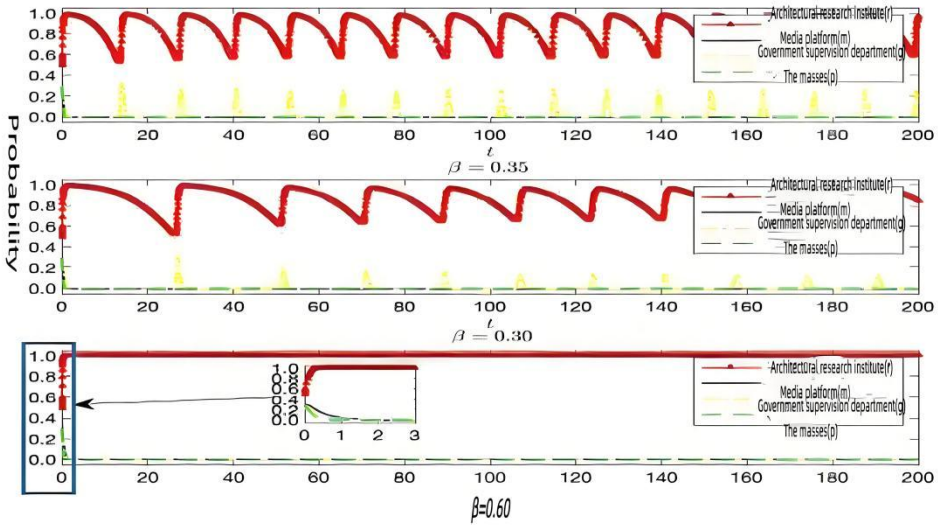
Set R_r={20,10,45,25} and R_m={10,6,30,25} respectively, the evolution process and results of strategies of four-party players are shown in Figure 7.



It can be observed from Figure 7 that with the augmentation of the reputational losses inflicted upon the construction research institution and the media platform by low-quality construction research reports, the probability of furnishing high-quality construction research reports escalates progressively and will ultimately stabilize at a state of high-quality construction research reports. As the probability of the construction research institution proffering high-quality construction research reports mounts, the probabilities of the media platform and the government regulatory department implementing strict supervision will wane gradually and eventually stabilize at 0. The probability of the public directly believing the construction research reports will reach a stable state of 1. Based on this, the public can formulate news processing decisions in light of the authorities of the construction research institution and the media platform, and the probability of accepting the relevant construction research reports released by minor platforms will finally stabilize at 1.

5.3 The influence of experts and architectural research institutions with professional advantages on the probability of false information

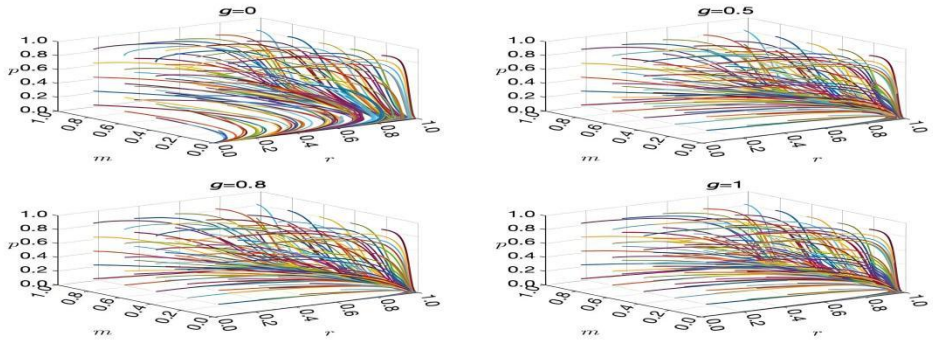
Letβ={0.35,0.30,0.60}, the strategy evolution process and results of the four-party game players are shown in Figure 8.



It can be discerned from Figure 8 that with the elevation of the probability of experts and non-governmental organizations possessing professional advantages refuting false information, the likelihood of the architectural research institution proffering low-quality research reports on green building projects diminishes substantially and will progressively enhance the probability of issuing high-quality research reports, ultimately attaining a stable state of providing high-quality research reports on green building projects. The government regulatory department can then gradually loosen its supervision and economize on supervision costs. Through such means, experts and non-governmental organizations with professional advantages can be spurred to refute inappropriate research reports on green building projects, thus effectively curtailing the occurrence probability of low-quality research reports on green building projects and protecting the interests of the public and society [11].

5.4 Influence of government supervision mechanism

Figure 9: The Impact of the Establishment of the Government Regulatory Mechanism on the Strategy Evolution of All Parties. In order to further verify the effectiveness and practicability of the regulatory mechanism of the government regulatory department in the quality development process of research reports on green building projects, with，g=0、g=0.5、g=0.8 and g=1respectively denoting the states of non-regulation and two forms of government regulatory department regulation, and to assess the evolution of different initial strategies of the architectural research institution, media platform and the public. The simulation results are presented in Figure 9.



It can be observed from Figure 9 that when g = 0, the government regulatory department refrains from supervising the investigation and reporting of construction research reports. Under such circumstances, the stability, reliability, credibility, and the risk of losing trust of the construction research reports by the government regulatory department are subject to a multitude of factors. The stable strategy of the media institution is not singular, and the strategy selection of the media platform predominantly leans towards opting not to conduct verification, with the aim of attaining higher profits and endeavoring to directly report the construction research reports promptly. When g = 0.5, the strategy choice of the media research institution principally inclines towards not performing verification to secure greater earnings. Amid the progressive intensification of the reporting of construction research by the government regulatory department, due to the

influence of diverse elements such as the risk of expert rumors and reputation damage, the stable strategy option of the government institution preponderantly tends towards a particular choice. The research indicates that if the stable strategy preference of the government institution preponderantly gravitates towards a certain direction, when g = 0.8, that is, in pursuit of a relatively elevated stability strategy, a supervision mechanism for the research coverage rate of green building projects is instituted thereon. Namely, since the government department abstains from supervising the research coverage rate of construction, in this scenario, given that the government department does not oversee the research coverage rate of green building projects, during the investigation phase, this discovery of the government is substantially in accord with the prior analysis of the stable strategy combinations under different government regulatory strategies. When g = 1, the government regulatory department has established a supervision and review mechanism for the research reports of green building projects. Although there exists a stable fixed point within the system, provided that the regulator can uphold a certain probability of supervision, then the probability of the construction research institution furnishing high-quality research reports of green building projects is essentially stabilized at. The aforesaid conclusion is congruent with the previous analysis of the stability of strategy combinations under different government regulatory strategies.

VI. Conclusions and recommendations

This research delves into the manner in which the quality of research reports on green building projects associated with the epidemic can be assured in the milieu of highly developed social media, by integrating the government's supervision mechanism with the professional strengths of experts and non-governmental organizations. The principal conclusions are as follows.

(1) In the developmental phase of the construction industry, the government ought to institute a regulatory framework for research reports on green building projects, so as to effectively curtail the speculation by construction research institutions and media platforms. The likelihood of national supervision is intimately correlated with the cost of supervision and the social losses stemming from improper reporting. Firstly, there is the reduction of supervision cost. During extraordinary periods, numerous construction units can orchestrate classified supervision, closely monitor analogous research institutions, and promptly validate the scientific veracity of construction research reports. Secondly, artificial intelligence technology should be vigorously advanced. Through artificial intelligence review, labor costs can be economized. Based on the assessment of social losses, the feasibility of construction research reports is scrutinized to address social issues in a timely fashion.

(2) While erecting a supervision system for construction research reports, the government regulatory department should also refine the punishment mechanism, augment the penalties for construction research institutions, severely chastise those behaviors that are conducive to premature reporting and news dissemination, as well as the unverified quality of media platforms. It should also stringently combat irresponsible conduct in society and the wanton release of news by media platforms without verification. While intensifying the punishments, construction research institutions should actively conduct scientific, standardized, and meticulous research work and furnish high-quality research reports, and the media platform should correspondingly enhance the probability of verifying reports.

(3) Experts and non-governmental organizations with professional advantages should be spurred to actively refute rumors and popularize construction knowledge. On the one hand, this can mitigate the losses occasioned by disorderly research reports on green building projects and halt the losses promptly. On the other hand, rumors can blemish the reputations of construction research institutions and media platforms. Post the release of the report, an augmentation in the rejection rate of experts implies that construction research institutions and media platforms will encounter greater reputational setbacks. Consequently, construction research institutions should supply high-quality construction research reports, and media platforms should discharge their obligations and ensure the scientific and accurate nature of news. Simultaneously, the public should be exhorted to remain rational, refrain from spreading or believing rumors, and actively heed the government's call. This article is predicated on the postulates of rational economics and expected utility theory. Nevertheless, during major public events, the decision-making process of each entity is readily swayed by subjective emotions.

6.1 Recommendations

In light of the overall underdeveloped state of the Chinese construction industry, the following five suggestions are proffered.

(1) Propel the innovative progression of the construction industry, establish and enhance a policy support infrastructure for technological innovation, and effectively manifest the competitive role of technological innovation in all facets of the entire life cycle of construction projects. Encourage high-caliber enterprises to fortify their cooperation with universities and research institutions, establish enterprise R & D hubs, foster the

development and dissemination of novel technologies and methodologies in the construction industry, and emerge as a crucial impetus for the innovative expansion of the construction industry.
(2) Promote the coordinated evolution of the construction industry. Further streamline administrative procedures and delegate authorities, open up to foreign investment, and expand foreign investment in the construction industry. Enable potent general contracting enterprises to actively explore the transition into engineering general contracting enterprises, and traditional supervision enterprises and engineering cost enterprises to metamorphose into whole-process consulting enterprises. Incite and support small and medium-sized construction enterprises to transmute into professional and technical enterprises, vigorously cultivate labor service enterprises, and regularize their labor practices.
(3) Propel the green advancement of the construction industry. Strengthen the supervision and governance of environmental pollution in construction projects, vigorously advocate green building projects and prefabricated structures, ceaselessly augment the utilization rate of prefabricated structures, curtail construction waste and material consumption, and substantially diminish construction noise and dust. Institute an incentive mechanism for building energy conservation and emission reduction, and augment subsidies for building energy conservation research projects and demonstration projects.
(4) Promote the international opening-up of the construction industry. Resolutely dismantle regional market barriers, rely on the national "Belt and Road" initiative, purge and annul local regulations that impede the unified and open construction market, engender a favorable construction market environment, and facilitate the unfettered flow of production factors in the construction industry. The government should erect an efficacious globalization policy support system, buttress and encourage local enterprises to intensify international cooperation, expand the scale of foreign projects, and actively explore overseas markets.
(5) Promote the common prosperity of the construction industry. Strengthen the social security within the industry, establish and perfect a long-term management mechanism for the arrears of migrant workers' wages, safeguard the legitimate rights and interests of migrant workers, actively resolve the quandary of determining the cost of construction projects subsequent to the substitution of business tax with value-added tax, effectively address the tax and fee burden of small and medium-sized enterprises, and foster the sustainable development of small and medium-sized enterprises.

REFERENCE

[1] Zhao R , Peng L , Feng Z Y .Coevolution mechanisms of stakeholder strategies in the green building technologies innovation ecosystem: An evolutionary game theory perspective[J].Environmental impact assessment review, 2024, 105(Mar.):107418.1-107418.21.DOI:10.1016/j.eiar.2024.107418.
[2] Li E , Ren S , Yang Y .Green transformation mechanisms and implementation path for agricultural clusters: A case study of the vegetable cluster in Shouguang city, Shandong province, China[J].Journal of Geographical Sciences, 2024, 34(12):2393-2420.DOI:10.1007/s11442-024-2297-9.
[3] Lou W .Digital Government Construction and Provincial Green Innovation Efficiency: Empirical Analysis Based on Institutional Environment in China[J].Sustainability, 2024, 16.DOI:10.3390/su162210030.
[4] Feng Q , Wang Y , Chen C ,et al.Effect of Homebuyer Comment on Green Housing Purchase Intention—Mediation Role of Psychological Distance[J].Frontiers in Psychology, 2021, 12:568451.DOI:10.3389/fpsyg.2021.568451.
[5] Pelini F , Greco A , Besana D ,et al.Recovery, Enhancement and Reuse of Existing Building Assets: Towards a New Reuse for Students[C]//International Conference of Ar.Tec. (Scientific Society of Architectural Engineering).Springer, Cham, 2025.DOI:10.1007/978-3-031-71855-7_36.
[6] Miyares B .Changing Science, Markets, & Economics Fuel Sustainability Course Corrections[J].Packaging world, 2024(5):31.
[7] Ariff A A A , Zawawi E M A , Yunus J ,et al.A systematic review for a highly accessible green roof for Malaysian public institution buildings[J].Journal of Facilities Management, 2022.DOI:10.1108/jfm-10-2021-0122.
[8] Hsieh Y Y , Shyue J J , Chao Y C ,et al.Chiral Binaphthalene Building Blocks for Self-Assembled Nanoscale CPL Emitters[J].Molecules, 2023, 28(8).DOI:10.3390/molecules28083382.
[9] Pandey V C , Gupta N , Niazi K R ,et al.A Bi-level Decision Framework for Incentive-Based Demand Response in Distribution Systems[J].ArXiv, 2023, abs/2306.00372.DOI:10.1109/tempr.2023.3282443.
[10] Wang F , Feng H .Does incentive-based green governance compensate for green innovation in enterprises? The role of green orientation[J].Environmental Science & Pollution Research, 2024, 31(5).DOI:10.1007/s11356-023-31671-6.
[11] Dunton J .Glancy Nicholls' 700-home Birmingham scheme set for green light[J].Building design, 2023(Jun.):1-2.
[12] Khadka C , Pandey G , Poudel A ,et al.Assessing Financial Management Practices and Accounting Mechanisms in Agricultural Cooperatives:A Case Study From Nepal[J].Management Studies, 2024, 12(3):146-171.
[13] Liu W , Harlow S .Tweeting in Solidarity: Examining Frame Diffusion and Alignment Processes Among Immigrant-Serving NGOs Before and After Donald Trump's Travel Ban[J].International Journal of Communication, 2020:6049-6071.
[14] Shou-hanDAI,Jia-binXU,YangWANG.The impacts of farmers' perceived benefits on green fertilization behaviors under environmental regulations[J].Research of Agricultural Modernization, 2021, 42(05):880-888.DOI:10.13872/j.1000-0275.2021.0098.
[15] Chen R , Chen Y .Government accounting supervision and risk of stock price crashes of listed companies: Evidence from the ministry of finance in China[J]. 2024.