ISSN: 2688-9323

Stability Analysis and Simulation of the Cooperative Evolution of the EPC Consortium Led by the Design Unit

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Abstract

From the perspective of the consortium cooperation relationship, this article conducts a game analysis on the cooperation evolution of the EPC consortium led by the design unit, and establishes the EPC consortium cooperation evolution SD based on system dynamics under two mechanisms: dynamic reward and dynamic punishment. model and perform simulations. The results show that: under the dynamic reward mechanism, the EPC consortium cooperation evolution is not stable, but as the number of games increases, the probability of construction units providing high-quality cooperation gradually reaches 100%; under the dynamic penalty mechanism, the EPC consortium cooperation Evolution has asymptotic stability. Measures for optimizing the cooperation strategies of both parties in the EPC consortium are proposed to provide a certain reference for the stable relationship between the partners of the EPC consortium led by the design unit.

Keywords

Design Unit Lead; EPC Consortium; Cooperative Evolutionary Game; System Dynamics; Stability Analys.

1. Introduction

At present, my country's general engineering contracting enterprises are facing the transformation from single qualifications for design and construction to dual qualifications for design and construction. However, during this transitional period, it will become a major trend for design units and construction units to form a consortium. Due to the complexity of the EPC project itself, there are many stakeholders in the consortium. Once the risk sharing is uneven or the income distribution is unreasonable, it will reduce the cooperation and enthusiasm of the consortium members, thus affecting the efficiency of the entire project, and even causing losses or losses. fail. Therefore, stable cooperation among EPC project consortium members is crucial to improving project benefits. In order to better implement the design concept, grasp the overall situation and plan coordination, and give full play to the innate advantages of the design unit, this article will use the design unit as the leading unit of the consortium. , carry out an analysis of the stability of cooperation in the EPC consortium.

Academic research on EPC consortia mainly focuses on the following three aspects. In terms of partner selection, methods such as TOPSIS [1], genetic algorithm [2], and particle swarm algorithm [3] are mainly used to establish a partner evaluation index system to conduct partner selection research. In terms of income distribution, social conflict theory [4], game theory [5], Shapley value method [6], Owen value method [7] and other methods are mainly used to establish income distribution models to evaluate the enthusiasm of consortium partners. Methods such as the Analytical Hierarchy Process [8] and Fussy-ISM [9] are widely used in risk management, or risk management models are established based on partnerships [10].

Through the above literature research and analysis, it can be concluded that scholars have done little research on the cooperative relationship among members within the consortium, and the stability of the cooperative relationship in the EPC consortium has not yet formed a preliminary understanding. In addition, the choice of cooperative relationships and cooperation strategies is dynamic. Therefore, from the perspective of the cooperation of the EPC consortium led by the design unit, this article analyzes the behavioral decisions of the design unit and the construction unit under the two situations of dynamic reward and dynamic punishment, and provides guidance for the stability of the cooperative relationship of the EPC consortium led by the design unit. Certain reference.

2. Analysis of the EPC Consortium Cooperation Evolution Game Led by the Design Unit

2.1. Parameter Setting

It is assumed that the two players in the evolutionary game are the design unit and the construction unit, both of whom are decision-makers with bounded rationality. As a member of the consortium, the main role of the construction unit is to cooperate in providing cooperative services, obtain certain benefits, and win social reputation and reputation. As the leader of the consortium, the design unit supervises and inspects the cooperation quality of the construction units, and rewards or punishes the construction units accordingly based on the quality of cooperation. See Table 1 for details of relevant parameters.

Table 1. Relevant parameters and sizes of the game model constructed by the construction unit

Parameter	Parameter Meaning	Parameter Size
C_H	The cost of high-quality cooperation provided by construction units	$C_H>0$
C_L	The cost of low-quality cooperation provided by construction units	$C_L>0$
π_0	Basic income of the consortium formed by construction units	$\pi_0>0$
π_H	Construction units provide incremental benefits from high-quality cooperation	$\pi_H>0$
π_L	Reduced benefits from low-quality cooperation provided by construction units	$\pi_L>0$
R_H	Improvement of credibility and reputation of construction units due to high-quality cooperation	$R_H>0$
α	The conversion coefficient of credibility and reputation improvement to future income	$1\geq\alpha\geq0$
R_L	The credibility and reputation of construction units are reduced due to low-quality cooperation	$R_L>0$
β	Conversion coefficient of reputation loss to future losses	$\beta>0$
P_H	Economic rewards received by construction units for high-quality cooperation	$P_H>0$
P_L	Economic penalties for construction units due to low-quality cooperation	$P_L>0$
x	The probability that the construction unit will provide high-quality cooperation	$1\geq x\geq0$

The design unit plays a leading role in the EPC consortium, and its income is related to whether the construction unit performs the contract according to quality. In addition, the EPC consortium is generally organized in the form of a project department. In order to increase the

ISSN: 2688-9323

on-site participation of the design unit and mobilize the supervisory motivation to optimize the design plan, the design unit will also be rewarded and punished. See Table 2 for details of its relevant parameters and meanings.

Table 2. Relevant parameters and sizes of the game model constructed by the design unit

Parameter	Parameter Meaning	Parameter Size
C	Design unit supervision costs	$C>0$
G_0	Basic income of a consortium of design units	$G_0>0$
G_H	The construction unit's performance of the contract will bring incremental benefits to the design unit at this stage	$G_H>0$
G_L	The construction unit's speculation brings reduced profits to the design unit at this stage	$G_L>0$
Q_H	Supervised by the design unit, additional benefits gained from proactively optimizing the design	$Q_H>0$
Q_L	Liability for dereliction of duty due to lack of supervision by the design unit	$Q_L>0$
y	Probability of design unit supervision	$1\geq y\geq 0$

2.2. Establishment of Game Payment Matrix

In the cooperation process of the EPC consortium led by the design unit, there is a mutual game process between the design and construction units, and both parties have two strategic behaviors, namely (supervision, no supervision), (high-quality cooperation, low-quality cooperation), And form a 2x2 order behavioral strategy matrix, thereby obtaining the EPC consortium game payment matrix, as shown in Table 3.

Table 3. Game payment matrix of the EPC consortium led by the design unit

		Design Unit	
		Supervision y	Non-Supervision $1-y$
Construction Unit	High Quality Cooperation x	$(-C_H+\pi_0+\pi_H+P_H+\alpha R_H,$ $-C+G_0+G_H+Q_H)$	$(-C_H+\pi_0+\pi_H,$ $G_0+G_H)$
	Low Quality Cooperation $1-x$	$(-C_L+\pi_0-\pi_L-P_L-\beta R_L,$ $-C+G_0-G_L)$	$(-C_L+\pi_0-\pi_L,$ $G_0-G_L-Q_L)$

When the design unit chooses the non-supervision strategy, the construction unit will definitely choose a low-quality cooperation strategy for its own benefits. That is, under the same circumstances, the benefits of low-quality cooperation are higher than those of high-quality cooperation. Therefore: $-C_L+\pi_0-\pi_L>-C_H+\pi_0+\pi_H$, that is: $C_H-C_L-\pi_H-\pi_L>0$. When the design unit chooses a supervision strategy, the construction unit will inevitably choose to provide high-quality cooperation strategies under the pressure of economic penalties. Therefore: $-C_H+\pi_0+\pi_H+P_H+\alpha R_H>-C_L+\pi_0-\pi_L-P_L-\beta R_L$. That is: $P_H+\alpha R_H+P_L+\beta R_L>C_H-C_L-\pi_H-\pi_L$.

When the construction unit chooses high-quality cooperation, the design unit will be more inclined to choose non-supervisory strategies in order to save manpower and material resources, so: $-C+G_0+G_H+Q_H<G_0+G_H$, that is, $Q_H<C$. When construction companies provide low-quality cooperation, design units tend to choose supervision strategies, therefore: $-C+G_0-G_L>G_0-G_L-Q_L$, that is: $C<Q_L$, $Q_H<C<Q_L$.

2.3. Copy the Construction of Dynamic Equations

(1) The expected return of high-quality cooperation of the construction unit is $E_x = y(P_H+\alpha R_H)-C_H+\pi_0+\pi_H$ E_x , then the expected return of low-quality cooperation of the construction unit is $E_{(1-x)}$, then $E_{(1-x)} = -y(P_L+\beta R_L)-C_L+\pi_0-\pi_L$, the average expected return is $\overline{E_x}$, then $\overline{E_x} = xE_x+(1-x)E_{(1-x)}$ the replication dynamic equation of the high-quality cooperation strategy provided by the construction unit is $F(x)$, then $F(x) = \frac{d_x}{d_t} = x(E_x-\overline{E_x}) = x(1-x)\,(E_x-E_{(1-x)})$ $= x(1-x)\,[y(P_H+\alpha R_H+P_L+\beta R_L)+C_L-C_H+\pi_L+\pi_H]$.

(2) The expected return of the design unit's supervision strategy is E_y , then $E_y = x(G_H+G_L+Q_H)-C+G_0-G_L$ the expected return of the design unit's non-supervision strategy is $E_{(1-y)}$, then $E_{(1-y)} = x(G_H+G_L+Q_L)+G_0-G_L-Q_L$, the average expected return is $\overline{E_y}$, then $\overline{E_y} = yE_y+(1-y)E_{(1-y)}$, the replication dynamic equation of the design unit providing high-quality cooperation strategy is $F(y)$, then $F(y) = \frac{d_y}{d_t} = y(E_X-\overline{E_X}) = y(1-y)\,(E_y-E_{(1-y)})$ $= y(1-y)\,[x(Q_H-Q_L)+Q_L-C]$.

3. Stability Analysis and Simulation of the Cooperative Evolution Game of the EPC Consortium Led by the Design Unit

In order to mobilize the enthusiasm and cooperation of construction units and improve the benefits of the EPC consortium, this article mainly considers two types of dynamic reward mechanisms and dynamic punishment mechanisms. Dynamic reward mechanism, that is P_L, the economic penalty is fixed, and the economic reward P_H changes with the quality of cooperation provided by the construction unit; dynamic penalty mechanism, that is P_H , the economic reward is fixed, and the economic penalty P_L changes with the degree of cooperation of the construction unit. In other cases, this article temporarily No discussion. Since the consciousness of providing high-quality cooperation is often linked to rewards and penalties, the higher the reward and the greater the punishment, the greater the probability of providing high-quality cooperation. Therefore, it can be assumed that $P_H=P_H(x)=P_{H0}x$, $P_L=P_L(\mathrm{x})=P_{L0}(1-x)$, P_{H0} represent the maximum reward amount given to the construction unit, and P_{L0} represent the maximum amount of punishment given to the construction unit, respectively, to analyze the stability of the EPC consortium design and construction unit cooperation evolution game under different mechanisms.

3.1. Analysis of Game Equilibrium Point of EPC Consortium Cooperation Evolution Under Dynamic Reward Mechanism

Evolutionarily Stable Strategy (ESS) is a game where gamers continue to repeat the game, and events will eventually tend to a stable strategy, and stable judgment conditions are the prerequisite for the evolution of a stable strategy. Replicator Dynamics Equation is a process of simulating the evolution and stability of events [11]. These two parts are the two core contents of evolutionary game theory.

Under the dynamic reward mechanism, the copy dynamic equation is:

$$\begin{cases} F(\mathrm{x}) = x(1-x)\,\{y[P_H(x)+\alpha R_H+P_L+\beta R_L]+C_L-C_H+\pi_H+\pi_L\} \\ F(y) = y(1-y)\,[x(Q_H-Q_L)+Q_L-C] \end{cases}$$

Five equilibrium points can be obtained, namely $E_1'(0,0)$, $E_2'(0,1)$, $E_3'(1,0)$, $E_4'(1,1)$, $E_5'(\frac{Q_L-C}{Q_L-Q_H}, \frac{\Delta C-\Delta\pi}{P_H(x^*)+\alpha R_H+\Delta\pi_2})$, where $x^*=\frac{Q_L-C}{Q_L-Q_H}$.

Then the Jacobin matrix of the evolutionary game system is:

$$J=\begin{bmatrix}(1-2x)\left[y(P_H(x)+\alpha R_H+\Delta\pi_2)-\Delta C+\Delta\pi\right]+xy(1-x)P_{H0} & x(1-x)(P_H(x)+\alpha R_H+\Delta\pi_2)\\ y(1-y)(Q_H-Q_L) & (1-2y)\left[x(Q_H-Q_L)+Q_L-C\right]\end{bmatrix}$$

The determinant and trace values of each equilibrium point are shown in Table 4.

Table 4. Determinant value and trace value of equilibrium point under dynamic reward system

	det(J)	Size	tr(J)	Size	Stability
E_1	$(-\Delta C+\Delta\pi)(Q_L-C)$	-	$-\Delta C+\Delta\pi+Q_L-C$	±	saddle point
E_2	$(\alpha R_H+\Delta\pi_2-\Delta C+\Delta\pi)(C-Q_L)$	-	$\alpha R_H+\Delta\pi_2-\Delta C+\Delta\pi+C-Q_L$	±	saddle point
E_3	$(\Delta C-\Delta\pi)(Q_H-C)$	-	$\Delta C-\Delta\pi+Q_H-C$	±	saddle point
E_4	$(P_{H0}+\alpha R_H+\Delta\pi_2-\Delta C+\Delta\pi)(Q_H-C)$	-	$-(P_{H0}+\alpha R_H+\Delta\pi_2-\Delta C+\Delta\pi)-(Q_H-C)$	±	saddle point
E_5	$\frac{(Q_L-C)(C-Q_H)(\Delta C-\Delta\pi)[P_{H0}(Q_L-C)+(Q_L-Q_H)(\alpha R_H+\Delta\pi_2-\Delta C+\Delta\pi)]}{(Q_L-Q_H)[P_{H0}(Q_L-C)+(\alpha R_H+\Delta\pi_2)(Q_L-Q_H)]}$	+	$\frac{(C-Q_H)(Q_L-C)(\Delta C-\Delta\pi)P_{H0}}{(Q_L-Q_H)[P_{H0}(Q_L-C)+(\alpha R_H+\Delta\pi_2)(Q_L-Q_H)]}$	+	saddle point

The determinant of the equilibrium point is $\det(J)>0$ and $\mathrm{tr}(J)<0$, and the equilibrium point is a local asymptotic stable point, which corresponds to an evolutionary stable strategy [12]. When the design unit chooses supervision, the construction unit often chooses high-quality cooperation.Therefore, $P_{H0}x+\alpha R_H+P_L+\beta R_L > C_H-C_L-\pi_H-\pi_L$, that is $P_{H0}x+\alpha R_H+\Delta\pi_2 > \Delta C-\Delta\pi$, through the relationship deduced above E_1 E_2 E_3 E_4, it can be known that 's $\det(J)<0$, E_5's $\det(J)>0$, but $\mathrm{tr}(J)>0$. From the above derivation analysis, it can be seen that E_1 E_2 E_3 E_4 E_5, Unstable saddle point. It shows that under the dynamic reward mechanism, the EPC consortium will not have an evolutionary equilibrium point in the cooperative evolutionary game.

3.2. Simulation Analysis of EPC Consortium Cooperation Evolution Game under Dynamic Reward Mechanism

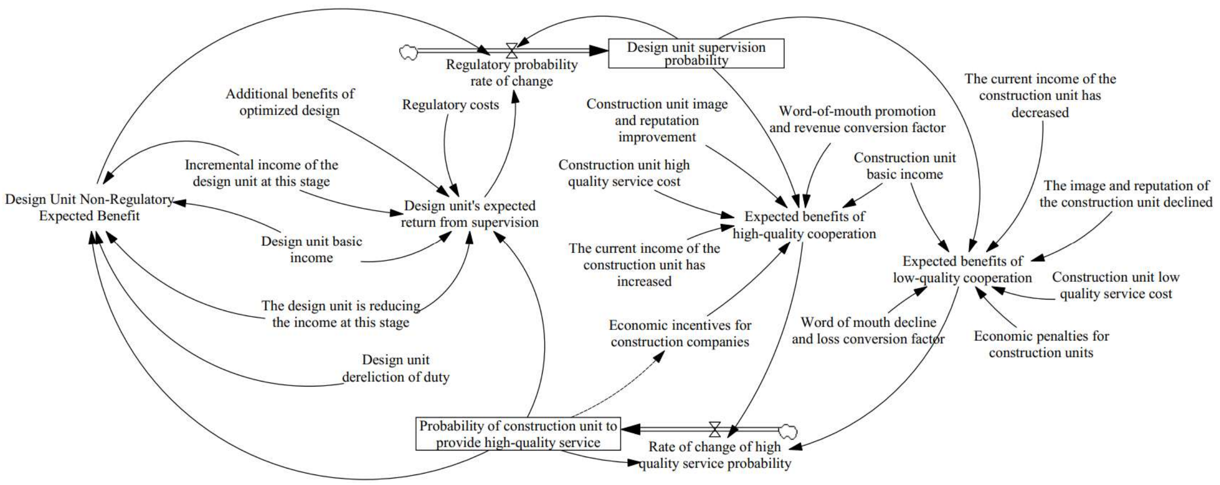

Figure 1. SD model of cooperation evolution of EPC consortium led by design unit under dynamic reward mechanism

Since the game between the two parties changes dynamically, this article uses system dynamics to simulate dynamic evolution. Therefore, this paper constructs an SD model of the cooperative evolution of the EPC consortium led by the design unit, as shown in Figure 1, and uses VENSIM software for simulation.

EPC projects are generally large and complex projects, with an average construction period of 3-5 years. Considering the stability of the EPC project partnership and the intuitiveness of the evolution trend display, this article sets the simulation time to 20 years, that is, INITIAL TIME =0, FINAL TIME=20, in years. The design unit supervises the cooperation quality of the construction unit every day, which means it supervises 30 times a month and 360 times a year, that is, TIME STEP=0.0028. Since this article mainly focuses on the trend and stability of the cooperative evolution game of EPC consortium, how to accurately assign values is not the focus of the research. Therefore, the corresponding data can be assigned according to the actual amount of the relevant project. Assume that the maximum economic reward and the maximum economic penalty are both 2 million. In order to fully simulate various situations, the behavioral strategies of the construction unit and the design unit are divided into 4 combinations. That is, (high-quality cooperation, high-probability supervision), (low-quality cooperation, high-probability supervision), (high-quality cooperation, low-probability supervision), (low-quality cooperation, low-probability supervision), and the initial states are respectively set to state one (0.75 ,0.75); state two (0.25,0.75); state three (0.75,0.25); state four (0.25,0.25). Through simulation, the results show that the evolution trend of the original game cycle is incomplete, so the behavioral evolution trends of both parties can be observed by expanding the game cycle. This article expands the game period by 4 times, that is, the simulation time is set to 80 years. The results are shown in Figures 2 and 3.

It can be seen from the above simulation diagram that under the dynamic reward mechanism and through long-term strategic cooperation, although the probability of the construction unit providing high-quality services changes periodically at the beginning, the final evolution trend is consistent, that is, the probability of providing high-quality cooperation reaches 100% , which also confirms the profit-seeking behavior of the construction unit. Through repeated games, the behavioral strategies of construction units show a certain degree of stability. However, the design unit will be driven by its own interests and may or may not adopt a regulatory strategy. The evolutionary game will eventually fail to converge and show instability.

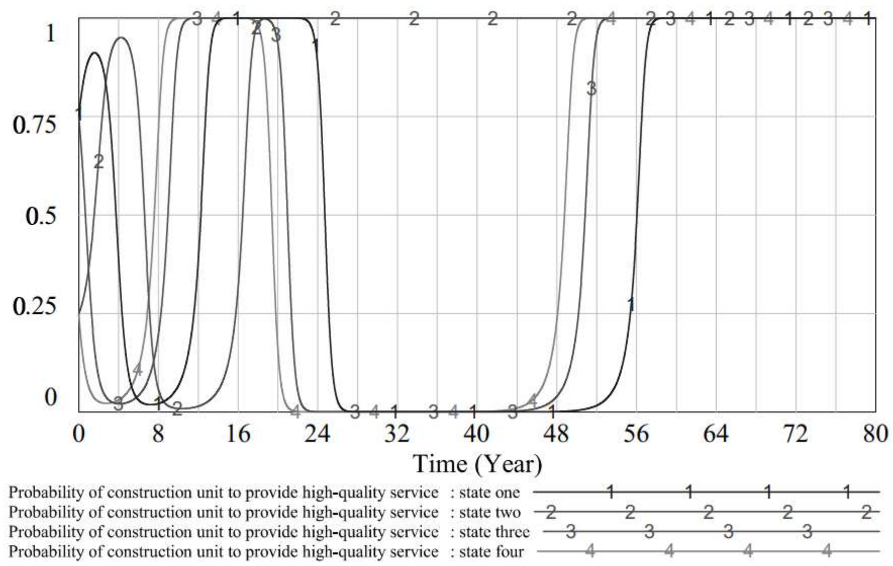

Figure 2. Simulation diagram of the probability of EPC consortium construction units providing high-quality services under the dynamic reward mechanism

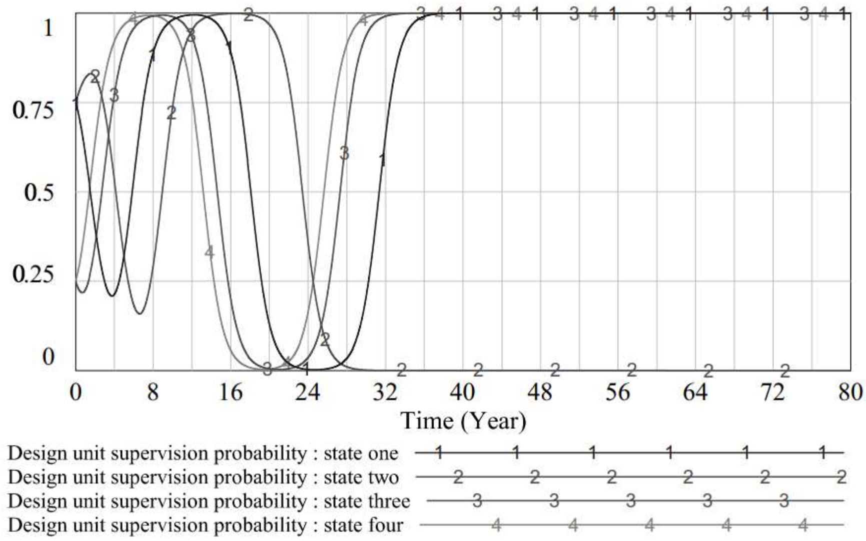

Figure 3. Simulation diagram of supervision probability of EPC consortium design unit under dynamic reward mechanism

3.3. Analysis of the Game Equilibrium Point of the Cooperation Evolution of EPC Consortium under the Dynamic Penalty Mechanism

Simultaneous equations, the replication dynamic equation under the dynamic penalty mechanism can be obtained as:

$$\begin{cases} F(\mathrm{x}) = x(1-x)\{y[P_H+\alpha R_H+P_L(\mathrm{x})+\beta R_L]+C_L-C_H+\pi_L+\pi_H\} \\ F(y) = y(1-y)[x(Q_H-Q_L)+Q_L-C] \end{cases}$$

Moreover, 5 equilibrium points can still be obtained, namely $E_1'(0,0)$, $E_2'(0,1)$, $E_3'(1,0)$, $E_4'(1,1)$, $E_5'(\frac{Q_L-C}{Q_L-Q_H}, \frac{\Delta C-\Delta\pi}{P_L(\mathrm{x}^{**})+\beta R_L+\Delta\pi_1})$, where $x^{**}=\frac{Q_L-C}{Q_L-Q_H}$.

The Jacobin matrix is expressed as:

$$J = \begin{bmatrix} (1-2x)\{y[\Delta\pi_1+P_L(\mathrm{x})+\beta R_L]-\Delta C+\Delta\pi\}-xy(1-x)P_{L0} & x(1-x)[\Delta\pi_1+P_L(\mathrm{x})+\beta R_L] \\ y(1-y)(Q_H-Q_L) & (1-2y)[x(Q_H-Q_L)+Q_L-C] \end{bmatrix}$$

The determinant and trace value of the equilibrium point are shown in Table 5.

Table 5. Determinant value and trace value of equilibrium point under dynamic penalty system

	det (J)	Size	tr(J)	Size	Stability
E_1	$(-\Delta C+\Delta\pi)(Q_L-C)$	-	$-\Delta C+\Delta\pi+Q_L-C$	±	saddle point
E_2	$(P_{L0}+\beta R_L+\Delta\pi_1-\Delta C+\Delta\pi)(C-Q_L)$	-	$P_{L0}+\beta R_L+\Delta\pi_1-\Delta C+\Delta\pi+C-Q_L$	±	saddle point
E_3	$(\Delta C-\Delta\pi)(Q_H-C)$	-	$\Delta C-\Delta\pi+Q_H-C$	±	saddle point
E_4	$(\beta R_L+\Delta\pi_1-\Delta C+\Delta\pi)(Q_H-C)$	-	$-(\beta R_L+\Delta\pi_1-\Delta C+\Delta\pi)+C-Q_H$	±	saddle point
E_5	$\frac{(C-Q_H)(Q_L-C)(\Delta C-\Delta\pi)[P_{L0}(C-Q_H)+(\beta R_L+\Delta\pi_1-\Delta C+\Delta\pi)(Q_L-Q_H)]}{(Q_L-Q_H)[P_{L0}(C-Q_H)+(\beta R_L+\Delta\pi_1)(Q_L-Q_H)]}$	+	$-\frac{(C-Q_H)(Q_L-C)(\Delta C-\Delta\pi)P_{L0}}{(Q_L-Q_H)[P_{L0}(C-Q_H)+(\beta R_L+\Delta\pi_1)(Q_L-Q_H)]}$	-	ESS

In the same way, $P_H + \alpha R_H + P_L(x) + \beta R_L > C_H - C_L - \pi_H - \pi_L$, that is $P_L(x) + \beta R_L + \Delta\pi_1 > \Delta C - \Delta\pi$, from the relationship deduced above, it can be seen that $E_1\ E_2\ E_3\ E_4$'s $\det(J) < 0$, $\det(J) > 0$ of E_5 .Therefore, in order to stabilize the focus E_5, under the dynamic penalty mechanism, the cooperative evolution of the EPC consortium led by the design unit has asymptotic stability.

3.4. Simulation Analysis of EPC Alliance Cooperation Evolution Game under Dynamic Punishment Mechanism

The SD model under the dynamic penalty mechanism is also constructed, as shown in Figure 4. The other parameter settings remain unchanged, and the situations in the above four initial states are also simulated in the VENSIM software, and Figures 5 and 6 can be obtained.

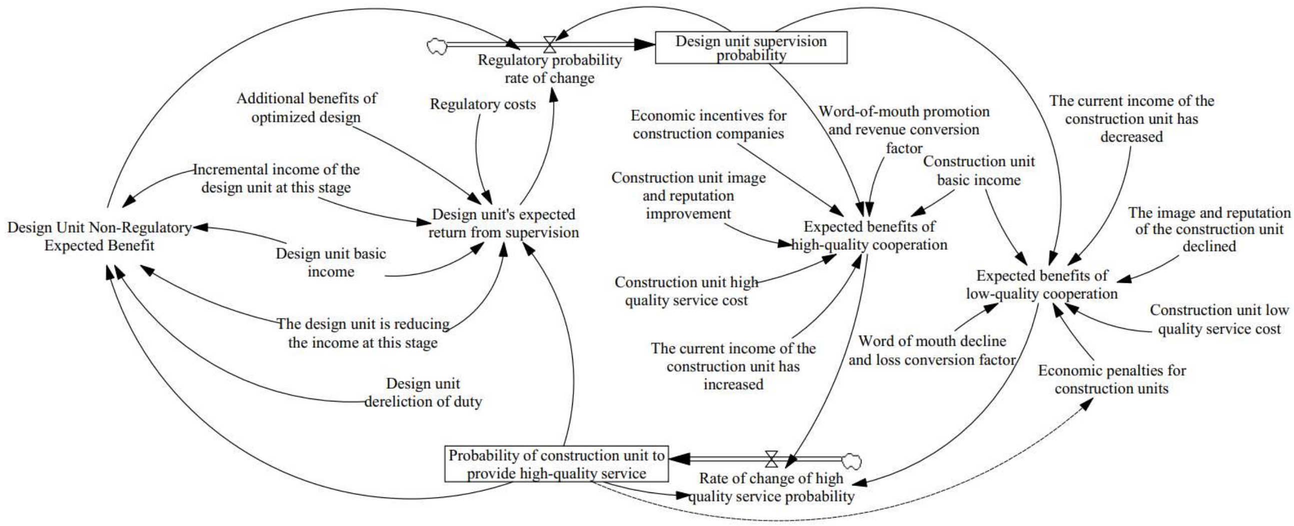

Figure 4. SD model of cooperation evolution of EPC consortium led by design unit under dynamic penalty mechanism

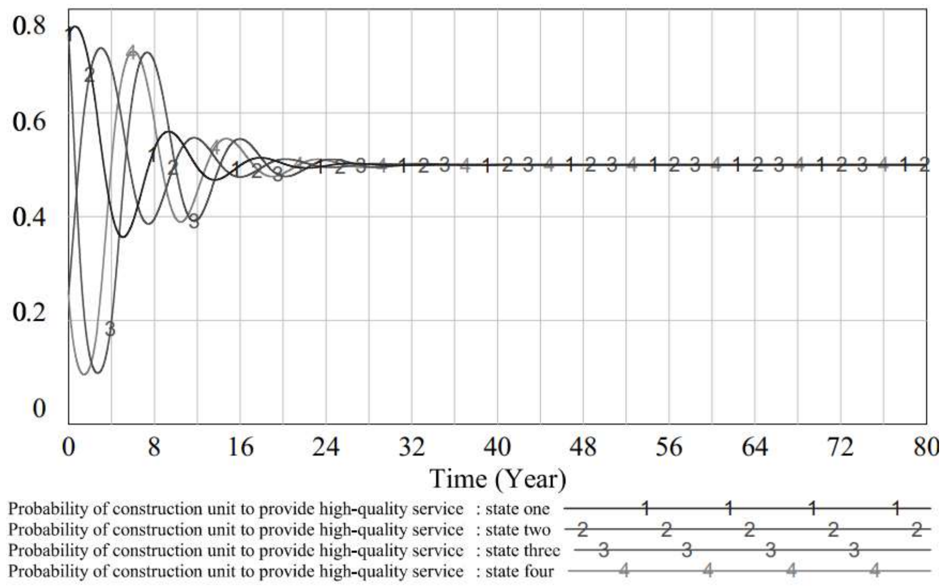

Figure 5. Simulation diagram of the probability of providing high-quality services by EPC consortium construction units under the dynamic penalty mechanism

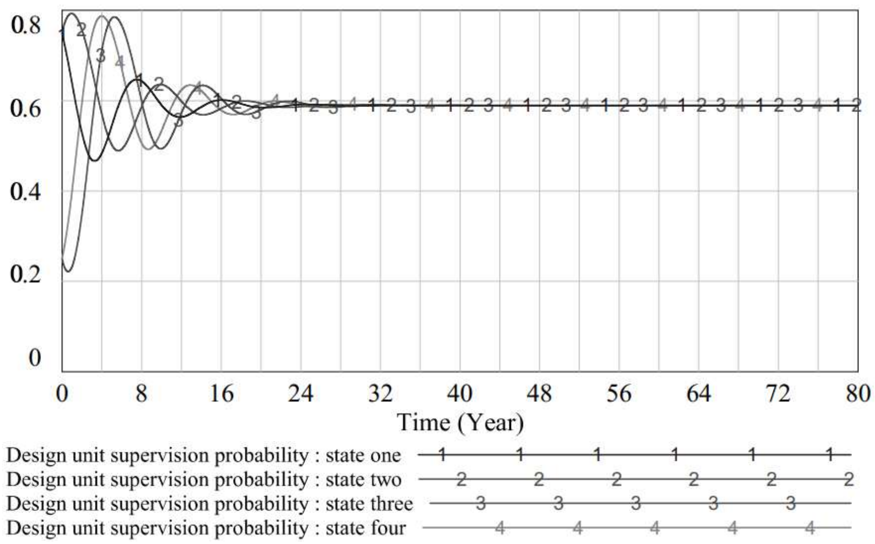

Figure 6. Simulation diagram of supervision probability simulation of EPC consortium design unit under dynamic penalty mechanism

It can be seen from the simulation results that under the dynamic penalty mechanism, as the cooperative subjects repeat the game, the strategic fluctuations of both parties gradually decrease and the evolutionary trend gradually converges. The supervision probability of the design unit and the high-quality cooperation probability of the construction unit eventually stabilize at the equilibrium point. The evolution of the two tends to be stable, and both parties will eventually tend to a certain stable strategy.

In addition, the probability that the construction unit provides high-quality services is related to the equilibrium point, that is, related to $\frac{Q_L - C}{Q_L - Q_H}$, Measures can be taken to reduce the supervision costs of the design unit, increase the design unit's rewards for optimized design and penalties for non-supervision and dereliction of duty, improve the probability of the construction unit providing high-quality services, and ensure the stability and high quality of the cooperation quality provided by the construction unit.

4. EPC Combined with Each Group Strategy Selection Optimization Measures based on Evolutionary Game Stability Analysis

4.1. Establish a Cooperative Organizational Structure and Strengthen Efficient Supervision

The members of the consortium are relatively independent and are only united because of their interests. Therefore, they value profits far more than the management of the consortium itself, and a reasonable organizational structure is the prerequisite for the consortium to make profits. In an EPC consortium led by a design unit, the management representative of the design unit can serve as the chairman of the consortium management committee. This can highlight the leading position of the design unit and strengthen the design unit's supervision of the consortium members, especially the construction unit. supervision. By establishing a reasonable management organizational structure, we can not only ensure the leading rights of the design unit, but also respect the individual interests of other consortium members, achieving a win-win effect. At the same time, a reasonable organizational structure and an efficient supervision model are conducive to reducing supervision costs, resisting project-related risks, improving communication efficiency among consortium members, and preventing EPC consortium partners from suffering joint liability losses.

4.2. Establish Strategic Partnership and Lengthen the Cooperation Cycle

Establishing a strategic cooperative relationship can deepen mutual understanding, promote the formation of a trusting relationship between both parties, improve mutual compatibility, and enhance the ability of unity and collaboration. Long-term cooperation, in addition to strengthening the sense of identity, can also cultivate a joint culture, reduce the running-in time, speed up the cooperation process, and help achieve long-term mutual benefit.

4.3. Highlight the Dominant Position of Design and Enhance the Revenue Distribution Mechanism

The EPC consortium led by the design unit should fully highlight the leading role of design. Design is not just a simple drawing, but needs to transform expertise into commercial value. For example: carry out design optimization, save costs and shorten the construction period. It can also be combined with BIM technology to improve communication efficiency and innovate thinking patterns and working mechanisms. At the same time, a reasonable income distribution mechanism is the guarantee for the cooperation motivation of the members of the consortium. An incentive and restraint system is established for all members of the consortium. Through target assessment of the consortium members, the intensity of rewards and punishments is increased to mobilize the enthusiasm of the members within the consortium. and cooperation, to minimize the probability that all parties in the consortium will choose to "provide low-quality services" and "not supervise".

5. Conclusion

From the perspective of the design unit, this article analyzes the stability of the cooperative relationship of the EPC consortium led by the design unit. By constructing an EPC consortium cooperative evolution game model and applying VENSIM software for simulation. The results show that under the dynamic reward mechanism, the cooperation evolution of the EPC consortium is not stable. However, as the number of games increases, the probability of the construction unit providing high-quality cooperation will reach 100%. However, it is uncertain whether the design unit adopts a supervision strategy. nature; under the dynamic penalty mechanism, the cooperation evolution of the EPC consortium has progressive stability, and the probability of the construction unit providing high-quality cooperation is related to the design unit's supervision cost, rewards for optimizing design, and penalties for failure to supervise. Therefore, this article proposes strategic optimization measures for both parties in the EPC consortium, namely establishing a cooperative organizational structure and strengthening efficient supervision; lengthening the cooperation cycle and establishing strategic partnerships; highlighting the dominant position in design and enhancing the revenue distribution mechanism. Provide a certain reference for the stability of the EPC consortium partnership led by the design unit.

Acknowledgments

Fund Project:1) Nanchong City Social Science Research "14th Five-Year Plan" 2023 Project (NC23C226).

2) The 22nd Extracurricular Open Experiment Key Project of Southwest Petroleum University (2022KSZ08007).

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ISSN: 2688-9323

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