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# Enhancing Green Port Construction through Advanced Computing: An Evolutionary Game Model under Social Accountability and Government Supervision

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***Abstract:* -** Ports, as pivotal hubs for global resource consumption and pollution emissions, have garnered considerable attention in the pursuit of sustainability. Despite the Chinese government's efforts in promoting the green construction of ports and a growing public awareness of environmental protection, progress remains sluggish, with pollution and energy consumption issues still rampant. This paper introduces an evolutionary game model that leverages advanced computing techniques, including big data analytics and simulation, to optimize green port construction strategies, supervision, and enforcement under the lens of social accountability. By applying the Jacobi matrix for analyzing equilibrium paths at diverse initial settings and conducting simulations under various scenarios of punishment intensity and social accountability probabilities, this study unveils that high social accountability likelihoods naturally incentivize ports towards green practices. Conversely, in low accountability scenarios, differentiated outcomes emerge from imposing penalties on ports and local governments. Notably, increasing penalties on ports substantially elevates green construction standards, whereas local government penalties exhibit only transient efficacy. Furthermore, leveraging artificial intelligence for predictive analysis and simulation demonstrates the critical role of technological advancements in enhancing green port construction. The study proposes augmenting penalties on ports, amplifying social oversight, and diminishing green construction costs via port consortia as strategic measures to expedite China's transition to green ports.

***Keywords:*** Green Port, Social Accountability, Government Supervision, Evolutionary Game, Big Data, Simulation, Artificial Intelligence.

## I. Introduction

With the globalization of trade and the expansion of the shipping industry, ports have ascended to critical nodes in the international trade and logistics network. Their role, however, comes with a significant environmental footprint, as they are major contributors to global energy consumption and pollution emissions, accounting for 20% to 40% of air pollutant emissions in numerous major cities. This substantial impact has catalyzed a concerted international effort to promote the sustainable development of ports, emphasizing the importance of environmental protection [1, 2]. In response to these challenges, China, a global export leader, has enacted various policies aimed at enhancing port environmental protection and promoting sustainable development, including the "Port and Ship Shore Electricity Management Method" in 2019 and "The 14th Five-Year Plan for the Development of Green Transportation" in 2021 [3, 4]. Despite these efforts, the journey towards green port construction in China faces significant hurdles, including technological barriers and financial constraints. Advanced environmental technologies require substantial investments, and the transition towards a green development model can temporarily reduce output [5]. Moreover, existing port environmental protection policies exhibit gaps, offering limited incentives for the adoption of green practices [6-10].

Historically, the discourse on green port construction has identified government subsidies and environmental taxes as key levers for fostering sustainable practices. The deployment of shore power technology emerges as a pivotal strategy for reducing port energy consumption and emissions. Studies suggest that precise subsidies for shore power can expedite this transition, with operational subsidies proving more effective than those for construction. The introduction of environmental taxes in the 1990s further underscores the role of fiscal policies in encouraging green port construction and emissions reduction [11-17]. The analytical power of game theory has been harnessed to explore the dynamics between government policies and green port construction, revealing the nuanced impact of carbon tax policies, government subsidies, and regulatory measures. This analytical framework has become increasingly relevant as green port construction approaches a critical juncture, highlighting the need for innovative approaches to policy development and implementation [18-21].

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This study innovates by integrating computer science methodologies—namely, big data analytics, the Internet of Things (IoT), artificial intelligence (AI), and simulation technologies—into the analysis of green port construction. This integration offers a multidimensional approach to tackling the environmental challenges faced by ports. Big data analytics enable the processing and analysis of vast datasets to identify patterns and trends that can inform policy and operational decisions. IoT devices facilitate real-time monitoring of environmental parameters, providing invaluable data for environmental management and compliance. AI and machine learning algorithms can predict the outcomes of various green construction strategies, optimizing resource allocation and environmental impact mitigation. Moreover, simulation technologies allow for the modeling of complex systems, enabling stakeholders to assess the potential impact of different policies and practices before their implementation.

This expanded focus on computer science and technology not only enriches the analytical framework of the study but also highlights the critical role of technological innovation in advancing green port construction. By leveraging these advanced computational techniques, the study aims to provide a comprehensive understanding of the interplay between social accountability, punitive mechanisms, and supervisory intensity in promoting sustainable port practices. The ultimate goal is to offer actionable insights and practical solutions for enhancing environmental sustainability in port operations, contributing to the broader efforts toward global environmental protection and sustainability.

## II. MODEL

This paper considers the game relationship between the local government and the port, both of whom are limited rational. In the game, the port has two strategies, namely positive green construction and negative green construction, and the local government also has two strategies, namely strict supervision and not strict supervision. It is assumed that the port and local government cannot observe the other's actions while playing the game, so the proposed game can be analyzed as a standard game where players act simultaneously. Table 1 shows the payoffs, in which the upper is the port's while the lower is the local government's. S_1 and S_2 denote the positive green and negative green construction strategy of the port, while S_3 and S_4 denote the local government's strict and not strict supervision strategy, respectively.

Table 1: Payoff of the Port and Local Government

| Port | Local Government | |
|---|---|---|
| | Strict Supervision($S_3$) | Not Strict Supervision($S_4$) |
| Positive Green Construction ($S_1$) | $\pi_1 - C_1$<br>$\pi_2 - C_2 - C_3$ | $\pi_1 - C_1$<br>$\pi_2 - C_2$ |
| Negative Green Construction ($S_2$) | $\pi_1 - C_1 - pF_1$<br>$\pi_2 - C_2 - C_3$ | $(1-p)\pi_1 - pF_1$<br>$(1-p)\pi_2 - p(C_2 + F_2)$ |

Suppose the port chooses the positive green construction strategy ($S_1$), its emissions and energy consumption will comply with related regulations. Thus, both the local government and the port will not be held accountable by the society. It is assumed that the port obtains revenue $\pi_1$ from its regular operation and spends cost $C_1$ on equipment purchase and technology introduction, and its payoff should be $\pi_1 - C_1 > 0$. For the local government, the benefit it gains from the public credibility is $\pi_2$, the impact of the temporary decline in transport capacity due to the port's active green construction on the local economy is $C_2$, and the cost of its strict supervision strategy is $C_3$.

Suppose the port adopts the negative green construction strategy ($S_2$) while the local government adopts the strict supervision strategy ($S_3$). In that case, the port will also be forced to pay $C_1$ for equipment purchase and technology introduction. However, its emissions and energy consumption will fail to meet the required standards, and it will possibly be held accountable and punished $F_1$ by environmental protection agencies.

Suppose the port applies the negative green construction strategy ($S_2$) and the local government applies the not strict supervision strategy ($S_4$). In that case, the standards on the port's emission and energy consumption are not met, and the port and local government will possibly be held accountable by the society. Besides, the shutdown or rectification notice will prevent the port from regular operation, before it is punished $F_1$ by environmental protection agencies. The local government will lose the benefit $\pi_2$ generated by the credibility, $C_2$ due to the port's irregular operation, and $F_2 (F_2 > C_3)$ as the punishment from the environmental protection agencies.

As there are over energy consumption and pollutant emission cases not been noticed, this paper assumes that there is a possibility p of the players being held accountable, and that p is related to the port size, the local government's benefits and the strategies adopted, i.e $p = P(\pi_1, \pi_2, S)$. As the media and the public will attach more attention to the large port enterprises and high-efficiency local governments, they are more likely to be held accountable, that is ($\frac{\partial P}{\partial \pi_1}, \frac{\partial P}{\partial \pi_2} > 0$). Considering the adopted strategy, the not strict supervision strategy from the local government often causes more severe problems in the port's energy consumption and pollutant emission. Therefore, the possibility of social accountability under the not strict supervision strategy is much higher, which means $P(\pi_1, \pi_2, S_3) < P(\pi_1, \pi_2, S_4)$. The related parameters are shown in Table 2.

Table 2: Related Parameters of the Game Players

| player | parameter | explain |
|---|---|---|
| port | $\pi_1$ | The profits when the port operates regularly |
| | $C_1$ | The cost of the port's positive green construction |
| | $F_1$ | Punishment on the port when being held accountable |
| local government | $\pi_2$ | The benefits of the local government from the public credibility |
| | $C_2$ | The impact of the declining port capacity on the local government |
| | $C_3$ | The cost of strict supervision by the local government |
| | $F_2$ | Punishment on the local government when being held accountable |
| other | $p$ | The social accountability probability |

According to the above assumptions, pure strategic Nash equilibrium can only occur in setting $(S_1, S_4)$ when $\pi_1 - C_1 > (1-p)\pi_1 - pF_1$ and $(S_2, S_4)$ when $\pi_1 - C_1 < (1-p)\pi_1 - pF_1$ and $(1-p)\pi_2 - p(C_2+F_2) > \pi_2 - C_2 - C_3$.

## III. Evolutionary Game Analysis

In the game between the port and the local government, suppose that the probability of the port adopting $S_1$ is $x$ and the probability of the local government adopting $S_3$ is $y$. Then, the port has the probability of $1-x$ adopting $S_2$, and the local government has the probability of $1-y$ adopting $S_4$. For the port, its expectation payoff is $E(u_1(S_1,y)) = \pi_1 - C_1$ when adopting $S_1$ and $E(u_1(S_2,y)) = -y(\pi_1 - C_1 - p_1F_1) + (1-y)\big((1-p_2)\pi_1 - p_2F_1\big)$ when adopting $S_2$. For the local government, its expectation payoff is $E(u_2(x,S_3)) = \pi_2 - C_2 - C_3$ when adopting $S_3$ and $E(u_2(x,S_4)) = x(\pi_2 - C_2) + (1-x)((1-p_2)\pi_2 - p_2(C_2+F_2))$ when adopting $S_4$. In this case, the expectation payoffs of the port and local government are:

$$E(u_1(x,y)) = xE(u_1(S_1,y)) + (1-x)E(u_1(S_2,y)) \tag{1}$$

$$E(u_2(x,y)) = yE(u_2(x,S_3)) + (1-y)E(u_1(x,S_4)) \tag{2}$$

The dynamic replication equations for the port and local government are:

$$F(x,y) = x[E(u_1(S_1,y)) - E(u_1(x,y))]$$
$$= x(1-x)[(\pi_1 - C_1) - y(\pi_1 - C_1 - pF_1) - (1-y)((1-p)\pi_1 - pF_1)] \tag{3}$$

$$G(x,y) = y[E(u_2(x,S_3)) - E(u_2(x,y))]$$
$$= y(1-y)[(\pi_2 - C_2 - C_3) - x(\pi_2 - C_2) - (1-x)((1-p)\pi_2 - p(C_2+F_2))] \tag{4}$$

The first order conditions are:

$$\frac{\partial F(x,y)}{\partial x} = (1-2x)[(\pi_1 - C_1) - y(\pi_1 - C_1 - pF_1) - (1-y)((1-p)\pi_1 - pF_1)] \tag{5}$$

$$\frac{\partial F(x,y)}{\partial y} = x(1-x)(-(\pi_1 - C_1 - pF_1) + ((1-p)\pi_1 - pF_1)) \tag{6}$$

$$\frac{\partial G(x,y)}{\partial x} = y(1-y)((1-p)\pi_2 - p(C_2+F_2) - (\pi_2 - C_2)) \tag{7}$$

$$\frac{\partial G(x,y)}{\partial y} = (1-2y)[(\pi_2 - C_2 - C_3) - x(\pi_2 - C_2) - (1-x)((1-p)\pi_2 - p(C_2+F_2))] \tag{8}$$

The Jacobi matrix is constructed as follows to analyze the stability of each game result [22]:

$$\Sigma = \begin{bmatrix} \frac{\partial F(x,y)}{\partial x} & \frac{\partial F(x,y)}{\partial y} \\ \frac{\partial G(x,y)}{\partial x} & \frac{\partial G(x,y)}{\partial y} \end{bmatrix}$$

The possible purely strategic outcomes of the game are $(x=1, y=1), (x=1, y=0), (x=0, y=1), (x=0, y=0)$, while the parameters will decide if the individual game result is stable. The equilibrium status under each parameter constraint is shown in Tables 3 to 5.

Table 3: Equilibrium Results under the First Constraint

| Possible Equilibrium Point | $p\pi_1 + pF_1 - C_1 > 0$ | | Conclusion |
|---|---|---|---|
| | $\frac{\partial F(x,y)}{\partial x}$ | $\frac{\partial G(x,y)}{\partial y}$ | |
| $x = 1, y = 1$ | - | + | Saddle point |
| $x = 1, y = 0$ | - | - | Stable point |
| $x = 0, y = 1$ | + | ± | Unstable point |
| $x = 0, y = 0$ | + | ± | Unstable point |

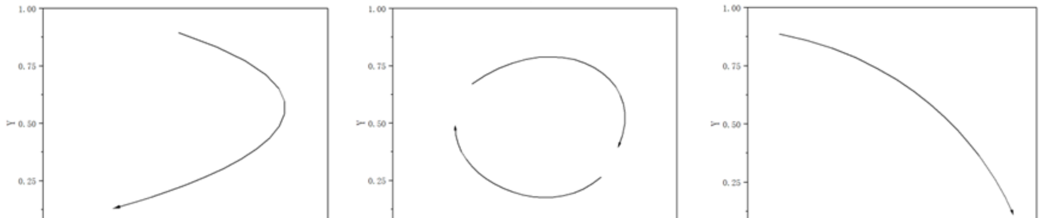
Table 4: Equilibrium Results under the Second Constraint

| Possible Equilibrium Point | $p\pi_1 + pF_1 - C_1 < 0$<br>$p\pi_2 + pC_2 + pF_2 - C_2 - C_3 > 0$ | | Conclusion |
|---|---|---|---|
| | $\frac{\partial F(x,y)}{\partial x}$ | $\frac{\partial G(x,y)}{\partial y}$ | |
| $x = 1, y = 1$ | - | + | Saddle point |
| $x = 1, y = 0$ | + | - | Saddle point |
| $x = 0, y = 1$ | + | - | Saddle point |
| $x = 0, y = 0$ | - | + | Saddle point |

Table 5: Equilibrium Results under the Third Constraint

| Possible Equilibrium Point | $p\pi_1 + pF_1 - C_1 < 0$<br>$p\pi_2 + pC_2 + pF_2 - C_2 - C_3 < 0$ | | Conclusion |
|---|---|---|---|
| | $\frac{\partial F(x,y)}{\partial x}$ | $\frac{\partial G(x,y)}{\partial y}$ | |
| $x = 1, y = 1$ | - | + | Saddle point |
| $x = 1, y = 0$ | + | - | Saddle point |
| $x = 0, y = 1$ | + | + | Unstable point |
| $x = 0, y = 0$ | - | - | Stable point |

According to the tables above, social accountability probability can decide if there are stable equilibrium paths in the game. When $p > \frac{C_1}{\pi_1+F_1}$, the evolution equilibrium result is $(x = 1, y = 0)$. In this case, the port adopts $S_1$ and the local government adopts $S_4$. When $\frac{C_2+C_3}{\pi_2+C_2+F_2} < p < \frac{C_1}{\pi_1+F_1}$, there is no stable equilibrium result. Therefore, the port and local government will adjust their strategies according to the other's choice constantly. When $p < \min\left(\frac{C_1}{\pi_1+F_1}, \frac{C_2+C_3}{\pi_2+C_2+F_2}\right)$, the evolution equilibrium result is $(x = 0, y = 0)$. In this case, the port adopts $S_2$ and the local government adopts $S_4$. The phases of each evolutionary game between the port and local government are shown in Figure 1.



(1) First Constraint (2) Second Constraint (3) Third Constraint

Figure 1: Phase Portrait of Probability Change in the Three Cases

The evolutionary path of the port is analyzed first. (1) when $p < \frac{C_1}{\pi_1+F_1}$, the port will adopt the positive green construction strategy if the local government adopts the strict supervision strategy and will adopt the negative green construction strategy if the local government adopts the not strict supervision strategy. (2) when $p > \frac{C_1}{\pi_1+F_1}$, the port will always adopt the positive green construction strategy no matter which strategy the local government adopts. (3) The punishment $F_1$ imposed by environmental protection agencies on the port can improve the probability of the port adopting the positive green construction strategy under the same conditions.

The evolutionary path of the local government is analyzed then. (1) when $p<\frac{C_2+C_3}{\pi_2+C_2+F_2}$, the local government will adopt the not strict supervision strategy no matter which strategy the port adopts. (2) When $p>\frac{C_2+C_3}{\pi_2+C_2+F_2}$, the local government will adopt the not strict supervision strategy if the port adopts the positive green construction strategy, while will adopt the strict supervision strategy if the port adopts the negative green construction strategy.

(3) The Punishment $F_2$ from the environmental protection agencies can improve the probability of the local government adopting strict supervision strategy under the same conditions.

In summary, this paper proposes that the evolutionary result is (positive green construction, not strict supervision strategy) when the social accountability probability is high and (negative green construction, not strict supervision strategy) if the probability is low. Besides, the evolutionary result should be (positive green construction, not strict supervision strategy) if high punishment is imposed.

## IV. SIMULATION

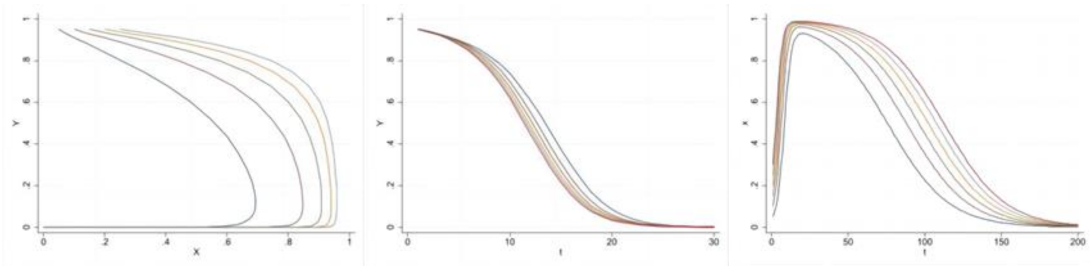
This paper further employs computer and artificial intelligence technologies to simulate data, providing a visual representation of the strategic variations between ports and local governments within the evolutionary game framework [23-24]. It offers a deeper understanding of the impact of penalties on equilibrium outcomes. By harnessing advanced computational methods and AI algorithms, we are able to process and analyze vast datasets more efficiently, enabling a comprehensive exploration of potential strategies and their outcomes [25]. This approach not only elucidates the dynamic interactions and decision-making processes of ports and governmental entities but also highlights the significance of technological innovation in environmental policy enforcement. Suppose $p$ is a linear function on $\pi_1$ and $\pi_2$, as shown below, when the local government adopts the mixed strategy.

$$p = P(\pi_1, \pi_2, S) = A(1-y) + b_1\pi_1 + b_2\pi_2 + D \quad (9)$$

Where $D > 0$ is the basic social accountability probability, and $A > 0$ is the additional social accountability probability due to excessive pollution or energy consumption. $b_1, b_2 > 0$ reflects the positive effect of the port and local government sizes on social accountability probability, and $y$ is the probability of the local government adopting the strict supervision strategy.

Based on previous research, the parameter values are set as follows in this paper: $\pi_1 = 50$, $C_1 = 20, \pi_2 = 100$, $C_2 = 20$, $C_3 = 35$. The measurement unit is amplified by 100 times to facilitate the probability calculation, so that the values of all parameters will not exceed 1. In the social accountability probability function, this paper assumes $b_1 = b_2 = 0.1\%$.

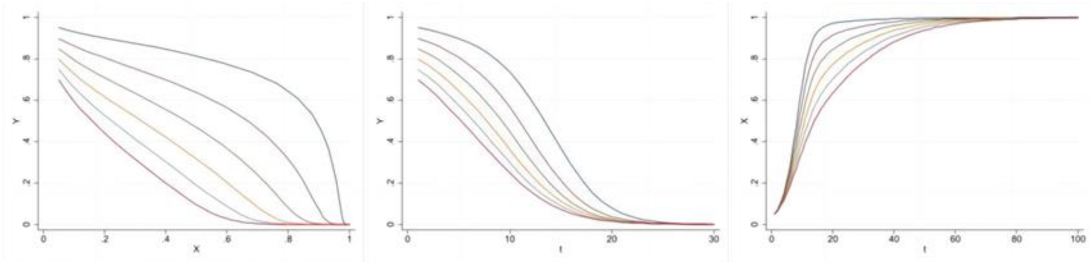
This paper first simulates the evolutionary game with different initial values (X, Y) when $p < \min\left(\frac{C_1}{\pi_1+F_1}, \frac{C_2+C_3}{\pi_2+C_2+F_2}\right)$ and the punishment on the port and local government are low. Specifically, $D$ is set as 0.1, $A$ is set as 0.05, and the penalties are set as 0, and the results are shown in Figure 2.



(1)y-x Curve Chart (2)y-t (time) Curve Chart (3)x-t (time) Curve Chart

Figure 2: Simulation under Low Social Accountability Probability

According to the simulation, the port adopting the green construction strategy and the local government adopting the not strict supervision strategy (X=0, Y=0) is always the evolutionary result regardless of the initial probability of the mixed strategy. However, the evolutionary game will change if environmental protection agencies increase the punishment on the port so that $P > \frac{C_1}{\pi_1+F_1}$. When $F_1$ is set as 50, for instance as shown in Figure 3, the evolutionary result will change into (X=1, Y=0). In this case, the port will adopt the positive green construction strategy, while the local government will adopt the not strict supervision strategy.

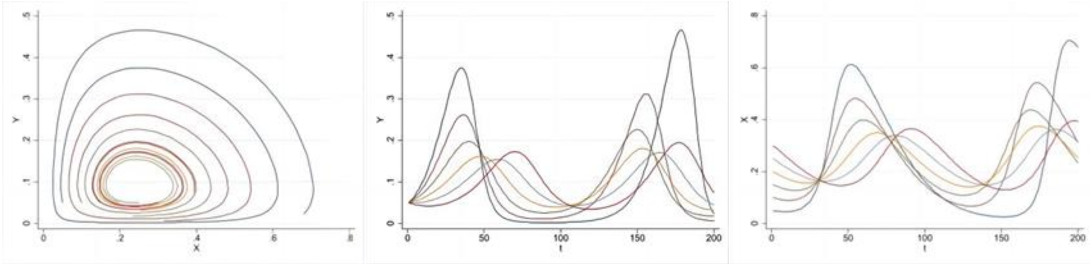


(1)x-y Curve Chart (2)y-t (time) Curve Chart (3)x-t (time) Curve Chart

Figure 3: Simulation when Increasing the Punishment on the Port

However, there is no pure strategic Nash equilibrium in the game when the environmental protection agencies increase the punishment on the local government. For simulation, $F_2$ is set as 100 to satisfy $\frac{C_2+C_3}{\pi_2+C_2+F_2} < P < \frac{C_1}{\pi_1+F_1}$, and the result is as shown in Figure 4.

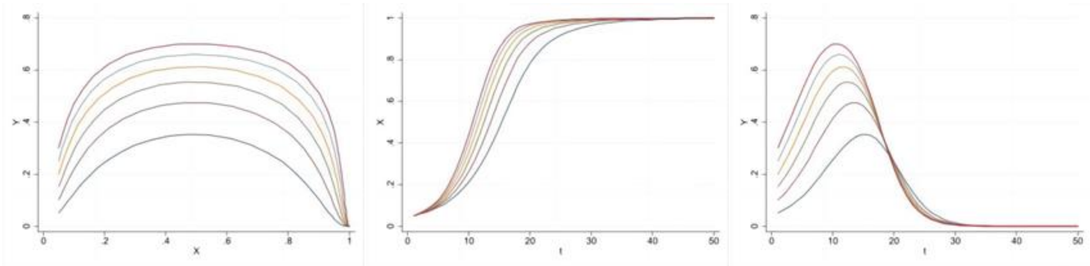
d strategy of postport and local government cannot reach equilibrium.



(1)x-y Curve Chart (2)y-t (time) Curve Chart (2)x-t (time) Curve Chart

Figure 4: Simulation when Increasing Punishment on the Local Government

A simulation is also conducted when the social accountability probability is high. Specifically, when $F_1$ and $F_2$ are set as 0, $D$ is set as 0.5, and $A$ is set as 0.1, (X=1, Y=0) is also the evolutionary result of the game. The result is as shown in Figure 5.



(1)x-y Curve Chart (2)y-t (time) Curve Chart (2)x-t (time) Curve Chart

Figure 5: Simulation under High Social Accountability Probability

## V. COUNTERMEASURES

The punishment on different players can lead to different paths in the evolutionary game, and social accountability plays an important role in promoting green port construction. In this case, related suggestions are proposed for the environmental protection agencies concerning green port construction as follows.

### *A. Direct Punishment and Personalized Standards through Computational Models*

While increasing port punishment is essential for promoting green construction intensity, the effectiveness of such punitive measures can be significantly enhanced by leveraging computational models. These models can help in designing personalized environmental standards and punishment measures by taking into account the unique geographical location, size, and load characteristics of different ports. Utilizing machine learning algorithms, environmental protection agencies can analyze vast amounts of data to determine the most effective standards and punishments, ensuring they are both operable and measurable.

### *B. Boosting Public Environmental Awareness with Digital Platforms*

The role of public environmental awareness is pivotal in augmenting social accountability. Here, computational technologies can play a transformative role. Digital platforms and social media analytics can be employed to gauge public opinion and awareness levels, tailor environmental education campaigns, and disseminate information about green port construction progress and its importance. Such platforms can also facilitate public participation in monitoring port activities, enabling a more inclusive approach to environmental governance.

### *C. Strengthening Cooperation through Technology-Enabled Networks*

The recommendation to strengthen the exchange and cooperation among port groups to reduce green construction costs can be effectively implemented through technology-enabled networks. Blockchain technology, for instance, can provide a secure and transparent mechanism for sharing information, resources, and best practices among port groups. This can facilitate centralized procurement, reduce redundant investments, and encourage collaborative research and development efforts, thereby lowering the costs associated with green port construction.

### D. Implementing IoT and AI for Monitoring and Compliance

The use of Internet of Things (IoT) devices for real-time environmental monitoring and artificial intelligence (AI) for data analysis can revolutionize the enforcement of green construction standards. IoT devices can monitor emissions, energy consumption, and other environmental indicators, providing a continuous stream of data. AI algorithms can then process this data to identify compliance issues, predict environmental impacts, and optimize green construction practices. This approach not only enhances the accuracy and efficiency of monitoring but also supports the development of predictive models for better decision-making.

## VI. Conclusion

The journey towards green port construction is a complex challenge that necessitates a multifaceted approach, combining regulatory measures, technological innovations, and societal engagement. This paper has demonstrated that while direct punishment and regulatory oversight play critical roles, the integration of computational technologies significantly amplifies the potential for achieving sustainable outcomes. Technologies such as IoT, AI, and digital platforms can provide the tools needed for more precise monitoring, personalized standard setting, and effective public engagement. Moreover, the collaboration facilitated by technology can bring down the costs of green construction, making it a more feasible option for ports. The use of computational models and data analytics can help tailor environmental policies to the specific needs and characteristics of each port, ensuring that the measures are not only effective but also fair and adaptable.

In summary, the evolution towards green port construction requires not just a change in policy or increased public awareness but a transformation in how we utilize technology to achieve these goals. By harnessing the power of computational technologies, we can create a more sustainable, efficient, and accountable framework for green port construction, setting a benchmark for environmental stewardship in the maritime sector. This holistic approach, which blends regulatory rigor with technological innovation and societal participation, paves the way for a sustainable future in port management and operations.

There is a lack of empirical analysis of green port construction in previous research, so it is difficult to unify the parameter units. Future research can take real ports as the evolutionary game samples to improve the path accuracy. Besides, social accountability and punishment can be further subdivided in research to provide more comprehensive and accurate conclusions. Last but not least, it is only through the joint efforts of the whole society that we can promote green port construction to a higher level and contribute to global sustainable development.

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## References

[1] International Maritime Organization, “Fourth IMO Greenhouse Gas Study 2020,” 2020.

[2] H. Cao, “How to choose between port and shipping under the green and low-carbon spring tide,” Economic Daily, Jan. 3, 2023.

[3] J. S. L. Lam and K. X. Li, “Green port marketing for sustainable growth and development,” Transport Policy, vol. 84, 2019, pp. 73-81.

[4] T. Hossain, M. Adams, and T. R. Walker, “Role of sustainability in global seaports,” Ocean & Coastal Management, vol. 202, 2021, pp.105435.

[5] L. Lester, Media and the Environment, in The Media and Communications in Australia, Routledge, 2020, pp. 321-326.

[6] C. Xu and Y. Zhang, “Evaluation of green port growth efficiency based on two-stage DEA — Take China’s listed port enterprises as an example,” Management and Administration, vol. 465, no. 3, 2023, pp. 101-107.

[7] W. Wang, J. Suo, L. Han, et al., “Evolutionary game analysis of green port construction under government regulation,” Journal of Systems Engineering, vol. 38, no. 1, 2023, pp. 30-45.

[8] H. Zhou and W. Zhang, “Research on emission reduction decision of port and ship under green port construction,” Science and Technology Management Research, vol. 42, no. 7, 2022, pp. 205-214.

[9] B. Meng, X. Zhang, H. Kuang, et al., "Research on the transformation, evolution and diffusion of green and smart ports based on government regulation," Chinese Journal of Management Science, vol. 30, no. 8, 2022, pp. 21-35.
[10] C. Liu, L. Heng, and S. Zhan, "Spatio-temporal evolution of green development efficiency in coastal ports in China," Journal of Shanghai Maritime University, vol. 43, no. 3, 2022, pp. 75-82.
[11] A. Martinez-Lopez, A. Romero, and J. A. Orosa, "Assessment of cold ironing and LNG as mitigation tools of short sea shipping emissions in port: a Spanish case study," Applied Sciences, vol. 11, no. 5, 2021, pp. 1-16.
[12] D. H, J. P. F. Trovão, and D. Williams, "Shore power as a first step toward shipping decarbonization and related policy impact on a dry bulk cargo carrier," Etransportation, vol. 11, 2022, pp.100150.
[13] X. Tao, Q. Wang, and H. Li, "Economic analysis of shore power," Climate Change Research, vol. 18, no. 4, 2022, pp. 492-502.
[14] L. Dai, H. Hu, Z. Wang, et al., "An environmental and techno-economic analysis of shore side electricity," Transportation Research, Part D: Transport and Environment, vol. 75, 2019, pp. 223–235.
[15] F. Pian, L. Xu, Y. Chen, et al., "Global emission taxes and port privatization policies under international competition," Sustainability, vol. 12, no. 16, 2020, pp.65-95.
[16] G. Sang and Y. Meng, "Game analysis of emission reduction decision of port and ship under carbon tax policy," Science and Technology Management Research, vol. 39, no. 21, 2019. pp. 227-235.
[17] S. Bullock, E. Higgins, J. Crossan, et al., "Improving shore power project economics at the Port of Aberdeen," Marine Policy, vol. 152, 2023, pp.105625.
[18] B. Lu and H. Wang, "Countermeasures of the Government to Facilitate Green Port Construction Based on Evolutionary Game Theory," East China Economic Management, vol. 31, no. 8, 2017, pp. 153-159.
[19] M. Parhamfar, I. Sadeghkhani, A. M. Adeli, "Towards the application of renewable energy technologies in green ports: Technical and economic perspectives," IET Renewable Power Generation, vol. 17, no. 12, 2023, pp. 3120-3132.
[20] T. Notteboom, L. van der Lugt, N. van Saase, et al., "The role of seaports in green supply chain management: Initiatives, attitudes, and perspectives in Rotterdam, Antwerp, North Sea Port, and Zeebrugge," Sustainability, vol. 12, no. 4, 2020, pp.1688.
[21] Z. H. Munim, H. Sornn-Friese, M. Dushenko, "Identifying the appropriate governance model for green port management: Applying Analytic Network Process and Best-Worst methods to ports in the Indian Ocean Rim," Journal of Cleaner Production, vol. 268, 2020, pp.122156.
[22] D. Friedman, "Evolutionary games in economics," Econometrica, vol. 59, no. 3, 1991, pp. 637-666.
[23] M. Abrams, J. Abrams, P. Cullen, et al., "Artificial Intelligence, Ethics, and Enhanced Data Stewardship," IEEE Security & Privacy, vol. 17, no. 2, 2019, pp. 17-30.
[24] X. L. Gu, F. Gao, M. Tan, P. Peng, "Fashion analysis and understanding with artificial intelligence," Information Processing & Management, vol. 57, no. 5, 2020, pp.102276.
[25] L. Bian, "Design of Computer Network Security Defense System Based on Artificial Intelligence and Neural Network," Wireless Personal Communications, 2023, pp.1-20.