Research Article

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Research on the structure of smart medical industry based on the background of the internet of things

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Abstract: In view of the current development trend of the smart medical industry in the context of the internet of things, this study conducts an evolutionary game analysis on information technology providers, medical institutions, digital medical equipment providers, and medical regulatory agencies in the smart medical industry. This study also analyzes the stable state of the future development of the smart medical industry and performs simulation calculations through MATLAB software. The research results show that the overall development trend of the smart medical industry structure in the future is consistent with the development trend of each industry structure. Under the strategic background of the supervision of medical regulatory agencies, information technology providers and digital medical equipment providers, respectively, provide the smart medical industry with the latest information technology and digital medical equipment to ensure the technical support of the smart medical industry. The smart medical industry provides corresponding medical talents and medical equipment to ensure the demand for talents and equipment of the smart medical industry, so that the structure of the smart medical industry can continuously improve the level of smart medical technology in the future development and ultimately promote the overall development of the smart medical industry.

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1 Introduction

With the rapid development of information technology, a smart medical industry is built on the basis of new information technologies such as the internet of things, artificial intelligence, blockchain, cloud computing, and big data, and the current medical industry resources are effectively integrated and used to renew reasonable allocation of medical industry resources to meet the huge public medical needs.

At present, the smart medical industry structure based on the internet of things mainly includes information technology providers that provide internet of things, 5G information and artificial intelligence and other technologies, and medical institutions that provide medical personnel and medical equipment. Provide smart medical applications and smart medical equipment-led digital medical equipment providers, as well as medical regulatory agencies that manage various related institutions in the smart medical industry. The key components of the smart medical industry structure are mainly formed through the integration of information technologies such as the internet of things and information-based digital medical equipment into the traditional medical environment. The current network model and functions of the medical Internet of Things are shown in Table 1 [1], while the construction of a new intelligent medical environment is used to break the regional resource limitations of traditional medical talents and medical industry, and to meet the medical and health needs of different scenarios in various regions, in order to promote the construction of the intelligent medical industry. According to the relevant smart medical industry research report, the scale of my country's smart medical construction industry reached 88 billion yuan in 2019, and the investment scale of China's smart medical

Table 1: Medical IoT network models and functions

Network level	Included	Function
Perception layer	RFID, one-dimensional code, two-dimensional code, sensor, infrared sensor, wearable device, monitoring terminal, etc.	Data collection
Network layer	ZigBee, Bluetooth, Wi-Fi, 3G/4G/5G cellular, NB-IoT, etc.	Data transmission
Platform layer	Various monitoring systems, cloud computing platforms, HIS systems, etc., in the hospital	Data storage and processing
Application layer	Medical equipment management, medical equipment positioning, remote diagnosis and surgery, etc.	Data application and interaction

industry in 2020 has exceeded 100 billion. According to this trend, the investment scale of China's smart medical industry will expand to 125.9 billion yuan in 2021 [2].

Therefore, this study mainly analyzes the information technology providers, medical institutions, digital medical equipment providers, and medical regulatory agencies in the composition of the smart medical industry and explores the future development trend of the smart medical industry, so as to provide reliable development suggestions for the future smart medical industry.

2 Evolutionary game model of smart medical industry structure based on internet of things

In view of the current development of the smart medical industry structure in the context of the internet of things [3,4], a new generation of information technology providers led by the provision of internet of things, 5G information, artificial intelligence, and other technologies provide medical personnel and medical equipment. An evolutionary game analysis was carried out on the four-party smart medical industry structure composed of the leading medical institutions, the digital medical equipment providers that provide smart medical applications and smart medical devices [5], and the medical regulatory agencies that manage smart medical institutions to study the future development trend of the smart medical industry structure in the context of the internet of things.

2.1 Model assumptions of smart medical industrial structure

Assumption 1. The smart medical industry based on the internet of things is regarded as a whole, and other external factors are not considered. The information technology providers that provide IoT, 5G information, and artificial intelligence technologies are set as participant 1, and medical institutions that provide medical personnel and medical equipment are set as participant 2. The digital medical equipment provider that provides smart medical applications and smart medical devices is set as participant 3, and the medical regulatory agency that manages various relevant institutions in the smart medical industry is set as participant 4.

Assumption 2. For each component of the smart medical industry structure, it is set as a bounded rational participant, that is, each participant in the industrial structure needs to choose the corresponding development strategy from the perspective of considering its own future development value. And only when information technology providers, medical institutions, and digital medical equipment providers jointly provide corresponding resources for the smart medical industry can the smart medical industry achieve breakthroughs in medical technology. Therefore, participant 1's strategy set $A = (A_1, A_2)$ = (provide the latest information technology for the smart medical industry and do not provide the latest information technology for the smart medical industry) [6], participant 2's strategy set $B = (B_1, B_2)$ = (provide medical talents and medical equipment for the smart medical industry and do not provide medical talents and medical equipment for the smart medical industry), participant 3's strategy set $C = (C_1, C_2)$ = (provide the latest digital medical equipment for the smart medical industry and do not provide the latest digital medical equipment for the smart medical industry) [7], and participant 4's strategy set $D = (D_1, D_2)$ = (supervise all relevant institutions in the smart medical industry and do not supervise various relevant institutions in the smart medical industry).

Assumption 3. In the current environment of rapid development of information technology, more and more information technology is applied to the medical field, which

can not only provide a more comfortable medical environment for patients, but also promote the common development of information technology and medical technology and provide wisdom. The medical industry provides more sufficient development impetus. Therefore, if the information technology provider provides the latest information technology for the smart medical industry and can help the smart medical industry to achieve breakthroughs in medical technology, it can obtain a profit R_1. If the information technology provider provides the latest information technology for the smart medical industry but fails to help the medical technology to achieve breakthroughs, it will obtain a profit R_2 and will also cause a loss of cost E_1. And regardless of whether the medical regulatory agency manages or not, the overall smart medical industry will subsidize the corresponding providers in the amount S_1 and the amount S_2 [8].

If the information technology provider chooses not to provide the latest information technology for the smart medical industry, in addition to not being able to obtain the profits brought by the smart medical treatment, it will also reduce the credit value T_1 of the smart medical industry to the information technology provider. And under the management of medical regulatory agencies, it is impossible to obtain subsidies for information technology providers from the overall smart medical industry. Under the condition that the medical supervision agency does not manage, for the development of the enterprise, the information technology provider obtains the subsidy amount S_3 of the smart medical industry through other channels.

Assumption 4. If a medical institution dominated by providing medical personnel and medical equipment chooses to provide medical personnel and corresponding medical equipment for the smart medical industry and assist the smart medical industry to achieve breakthroughs in medical technology, it can obtain a profit of R_3. If the medical institution provides the corresponding talents and equipment resources for the smart medical industry but fails to assist the smart medical industry to achieve a breakthrough in medical technology, it will also obtain a profit of R_4, but also cause a loss of cost E_2. And regardless of whether the medical regulatory agency supervises or not, the smart medical industry will issue subsidy amounts S_4 and S_5 to the corresponding medical institutions [9].

If a medical institution dominated by providing medical personnel and medical equipment chooses not to provide medical personnel and corresponding medical equipment for the smart medical industry, in addition to not being able to obtain the profits brought by smart medical care, it will also reduce the credit value T_2 of the smart medical industry to the medical institution. And under the condition of the management of the medical regulatory agency, the subsidy of the smart medical industry for the medical institution cannot be obtained. In the absence of management by the medical regulatory agency, the medical institution obtains the subsidy amount S_6 of the overall smart medical industry through other channels for its own development.

Assumption 5. If you are a digital medical device provider that provides smart medical applications and smart medical devices choose to provide smart medical applications and smart medical devices for the smart healthcare industry. If it chooses to provide smart medical applications and smart medical devices for the smart medical industry and help the smart medical industry achieve breakthroughs in medical technology, it can get a profit of R_5. If the digital medical equipment provider provides corresponding smart medical applications and smart medical devices for the smart medical industry but fails to assist the smart medical industry to achieve breakthroughs in medical technology, it will also gain profit R_6, but also cause a loss of cost E_3. And regardless of whether the medical regulatory agency supervises or not, the smart medical industry will issue subsidy amounts S_7 and S_8 to the corresponding digital medical equipment providers.

If a digital medical equipment provider dominated by providing smart medical applications and smart medical devices chooses not to provide smart medical applications and smart medical devices for the smart medical industry, in addition to not being able to obtain the profits brought by smart medical care, it will also reduce the credit value T_3 of the smart medical industry to the digital medical equipment provider. And under the management of medical regulatory agencies, it is impossible to obtain subsidies for the digital medical equipment provider from the smart medical industry. In the absence of management by the medical regulatory agency, the digital medical equipment provider obtains the subsidy amount S_9 of the smart medical industry through other channels for its own development.

Assumption 6. Medical regulators will receive R_7 rewards each time they perform their regulatory responsibilities and will also supervise information technology providers, medical institutions, and digital medical equipment providers in accordance with the rules of the smart medical industry. If the medical supervision institution does not fulfill the supervision responsibility, it will be punished with a fine of F_1; at the same time, the penalty intensity

coefficient α is set to represent the degree of punishment that medical regulatory agencies in the smart medical industry will accept when they fail to fulfill their regulatory responsibilities, thus illustrating the collaborative development trend within the smart medical industry in the evolutionary game process.

Assumption 7. The probability that the information technology provider chooses to provide the latest information technology strategy for the smart medical industry is x, and the probability of choosing not to provide the latest information technology strategy for the smart medical industry is $1 - x$. The probability of medical institutions choosing to provide medical talents and medical equipment strategies for the smart medical industry is y, and the probability of choosing not to provide medical personnel and medical equipment strategies for the smart medical industry is $1 - y$. The probability that a digital medical equipment provider chooses to provide the latest digital medical equipment strategy to the smart medical industry is z, and the probability that it chooses not to provide the latest digital medical equipment strategy to the smart medical industry is $1 - z$. The probability that the medical regulatory agency chooses to implement a supervision strategy for each relevant institution in the smart medical industry is k, and the probability that it chooses not to implement a supervision strategy for each relevant institution in the smart medical industry is $1 - k$. x, y, z, and k are all functions of time t [10,11].

2.2 Construction of evolutionary game model of smart medical industry structure

According to the assumptions of the above model, construct a quadrilateral evolutionary game model for information technology providers, medical institutions, digital medical equipment providers, and medical regulators in the smart medical industry structure and analyze the development of each part in the smart medical industry structure. The future development trend of the smart medical industry can be obtained [12]. The evolutionary game income matrix corresponding to the smart medical industry structure is shown in Table 2.

According to the evolutionary game revenue matrix corresponding to the smart medical industry structure in Table 2 [13], calculate the expected revenue G_{A1} of the information technology provider for providing the latest information technology strategy to the smart medical industry and calculate the expected revenue G_{A2} that does not provide the smart medical industry with the latest digital medical equipment strategy. Finally, calculate the average return G_A of strategy selection; the specific information is shown in formulas (1)–(3).

$$G_{A1} = (R_1 + S_1)(yz) + (R_2 - E_1 + S_2)(1 - yz), \tag{1}$$

$$G_{A2} = (-T_1)k + (-T_1 + S_3)(1 - k), \tag{2}$$

$$G_A = xG_{A1} + (1 - x)G_{A2}. \tag{3}$$

Table 2: Evolutionary game income matrix corresponding to the smart medical industry structure

Strategy mix				Strategic portfolio return			
				Information technology	Medical institutions	Digital health	Medical supervision
X	y	z	k	R1 + S1	R3 + S4	R5 + S7	R7
x	y	z	$1 - k$	R1 + S1	R3 + S4	R5 + S7	−αF1
x	y	$1 - z$	k	R2 − E1 + S2	R4 − E2 + S5	−T3	R7
x	y	$1 - z$	$1 - k$	R2 − E1 + S2	R4 − E2 + S5	−T3 + S9	−αF1
x	$1 - y$	z	k	R2 − E1 + S2	−T2	R6 − E3 + S8	R7
x	$1 - y$	z	$1 - k$	R2 − E1 + S2	−T2 + S6	R6 − E3 + S8	−αF1
x	$1 - y$	$1 - z$	k	R2 − E1 + S2	−T2	−T3	R7
x	$1 - y$	$1 - z$	$1 - k$	R2 − E1 + S2	−T2 + S6	−T3 + S9	−αF1
$1 - x$	y	z	k	−T1	R4 − E2 + S5	R6 − E3 + S8	R7
$1 - x$	y	z	$1 - k$	−T1 + S3	R4 − E2 + S5	R6 − E3 + S8	−αF1
$1 - x$	y	$1 - z$	k	−T1	R4 − E2 + S5	−T3	R7
$1 - x$	y	$1 - z$	$1 - k$	−T1 + S3	R4 − E2 + S5	−T3 + S9	−αF1
$1 - x$	$1 - y$	z	k	−T1	−T2	R6 − E3 + S8	R7
$1 - x$	$1 - y$	z	$1 - k$	−T1 + S3	−T2 + S6	R6 − E3 + S8	−αF1
$1 - x$	$1 - y$	$1 - z$	k	−T1	−T2	−T3	R7
$1 - x$	$1 - y$	$1 - z$	$1 - k$	−T1 + S3	−T2 + S6	−T3 + S9	−αF1

Therefore, the replication dynamic equation of the strategy corresponding to the information technology provider in the composition of the smart medical industry structure is shown in formula (4).

$$\begin{aligned} F'_A(x) &= \frac{dx}{dt} = x(G_{A1} - G_A) \\ &= x(1-x)(G_{A1} - G_{A2}) \\ &= x(1-x)[(R_1 + S_1)yz + (R_2 - E_1 + S_2)(1-yz) \\ &\quad + (T_1 - S_3 + S_3k)]. \end{aligned} \tag{4}$$

Then, according to the evolutionary game revenue matrix corresponding to the smart medical industry structure in Table 2, first calculate the expected revenue G_{B1} of the strategy of medical institutions providing medical talents and medical equipment for the smart medical industry, and second, calculate the expected revenue G_{B2} of the strategy of medical institutions not providing medical talents and medical equipment for the smart medical industry. Finally, the average return G_B of the strategy selection is calculated, and the specific information is shown in formulas (5)–(7).

$$G_{B1} = (R_3 + S_4)(xz) + (R_4 - E_2 + S_5)(1 - xz), \tag{5}$$

$$G_{B2} = (-T_2)k + (-T_2 + S_6)(1-k), \tag{6}$$

$$G_B = yG_{B1} + (1-y)G_{B2}. \tag{7}$$

Therefore, the replication dynamic equation of the corresponding strategies of medical institutions in the composition of the smart medical industry structure is shown in formula (8).

$$\begin{aligned} F'_B(y) &= \frac{dy}{dt} = y(G_{B1} - G_B) \\ &= y(1-y)(G_{B1} - G_{B2}) \\ &= y(1-y)[(R_3 + S_4)xz + (R_4 - E_2 + S_5)(1-xz) \\ &\quad + (T_2 - S_6 + S_6k)]. \end{aligned} \tag{8}$$

Similarly, according to the evolutionary game revenue matrix corresponding to the smart medical industry structure in Table 2, first calculate the expected revenue G_{C1} of the digital medical equipment provider choosing to provide the latest digital medical equipment strategy for the smart medical industry, and second, calculate the expected revenue G_{C2} that does not provide the latest digital medical equipment strategy for the smart medical industry. Finally, the average return G_C of the strategy selection is calculated. The specific information is shown in formulas (9)–(11).

$$G_{C1} = (R_5 + S_7)(xy) + (R_6 - E_3 + S_8)(1 - xy), \tag{9}$$

$$G_{C2} = (-T_3)k + (-T_3 + S_9)(1-k), \tag{10}$$

$$G_C = zG_{C1} + (1-z)G_{C2}. \tag{11}$$

Therefore, the replication dynamic equation of the corresponding strategies of digital medical equipment providers in the composition of the smart medical industry structure is shown in formula (12).

$$\begin{aligned} F'_C(z) &= \frac{dz}{dt} = z(G_{C1} - G_C) \\ &= z(1-z)(G_{C1} - G_{C2}) \\ &= z(1-z)[(R_5 + S_7)xy + (R_6 - E_3 + S_8)(1-xy) \\ &\quad + (T_3 - S_9 + S_9k)]. \end{aligned} \tag{12}$$

Finally, according to the evolutionary game revenue matrix corresponding to the smart medical industry structure in Table 2, first calculate the expected revenue G_{D1} of the medical regulatory agency's choice of the supervision strategy for each relevant institution in the smart medical industry, and then calculate the institution does not carry out the expected return G_{D2} of the supervision strategy, and finally, calculate the average return G_D of the strategy selection. The specific information is shown in formulas (13)–(15).

$$G_{D1} = R_7, \tag{13}$$

$$G_{D2} = -\alpha F_1, \tag{14}$$

$$G_D = kG_{D1} + (1-k)G_{D2}. \tag{15}$$

Therefore, the replication dynamic equation of the strategy corresponding to the medical regulatory agency in the composition of the smart medical industry structure is shown in formula (16).

$$\begin{aligned} F'_D(k) &= \frac{dk}{dt} = k(G_{D1} - G_D) \\ &= k(1-k)(G_{D1} - G_{D2}) \\ &= k(1-k)(R_7 + \alpha F_1). \end{aligned} \tag{16}$$

2.3 Prediction and analysis of the development trend of smart medical industry structure

According to the quadrilateral evolutionary game model of information technology providers, medical institutions, digital medical equipment providers, and medical regulators in the smart medical industry structure, let the model formulas (4), (8), (12), and (16) be zero. The obtained equilibrium point is brought into the Jacobian matrix of formula (17) to judge whether it can evolve stably, so as to obtain the future development trend of the smart medical industry structure [14].

When the eigenvalues corresponding to the equilibrium point are all negative numbers, the equilibrium

point is the evolutionary stable point of the composition of the smart medical industry structure, which means the future development trend of the smart medical industry structure. When there is a positive number, it means that the equilibrium point is not an evolutionary stable point composed of the smart medical industry structure; and when the eigenvalues required by the equilibrium point are 0 and the remaining eigenvalues are negative, it means that the equilibrium point is at critical evolutionary steady state.

$$J = \begin{bmatrix} \frac{dF'_A(x)}{dx} & \frac{dF'_A(x)}{dy} & \frac{dF'_A(x)}{dz} & \frac{dF'_A(x)}{dk} \\ \frac{dF'_B(y)}{dx} & \frac{dF'_B(y)}{dy} & \frac{dF'_B(y)}{dz} & \frac{dF'_B(y)}{dk} \\ \frac{dF'_C(z)}{dx} & \frac{dF'_C(z)}{dy} & \frac{dF'_C(z)}{dz} & \frac{dF'_C(z)}{dk} \\ \frac{dF'_D(k)}{dx} & \frac{dF'_D(k)}{dy} & \frac{dF'_D(k)}{dz} & \frac{dF'_D(k)}{dk} \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} & a_{13} & a_{14} \\ a_{21} & a_{22} & a_{23} & a_{24} \\ a_{31} & a_{32} & a_{33} & a_{34} \\ a_{41} & a_{42} & a_{43} & a_{44} \end{bmatrix}. \quad (17)$$

The values of a_{11} to a_{44} are shown in formulas (18)–(33).

$$a_{11} = (1 - 2x)[(R_1 + S_1)yz + (R_2 - E_1 + S_2)(1 - yz) + (T_1 - S_3 + S_3k)], \quad (18)$$

$$a_{12} = x(1 - x)z[(R_1 + S_1) + (R_2 - E_1 + S_2)], \quad (19)$$

$$a_{13} = x(1 - x)y[(R_1 + S_1) + (R_2 - E_1 + S_2)], \quad (20)$$

$$a_{14} = x(x - 1)S_3, \quad (21)$$

$$a_{21} = y(1 - y)z[(R_3 + S_4) - (R_4 - E_2 + S_5)], \quad (22)$$

$$a_{22} = (1 - 2y)[(R_3 + S_4)xz + (R_4 - E_2 + S_5)(1 - xz) + (T_2 - S_6 + S_6k)], \quad (23)$$

$$a_{23} = y(1 - y)x[(R_3 + S_4) - (R_4 - E_2 + S_5)], \quad (24)$$

$$a_{24} = y(1 - y)S_6, \quad (25)$$

$$a_{31} = z(1 - z)y[(R_5 + S_7) - (R_6 - E_3 + S_8)], \quad (26)$$

$$a_{32} = z(1 - z)x[(R_5 + S_7) - (R_6 - E_3 + S_8)], \quad (27)$$

$$a_{33} = (1 - 2z)[(R_5 + S_7)xy + (R_6 - E_3 + S_8)(1 - xy) + (T_3 - S_9 + S_9k)], \quad (28)$$

$$a_{34} = z(1 - z)S_9, \quad (29)$$

$$a_{41} = 0, \quad (30)$$

$$a_{42} = 0, \quad (31)$$

$$a_{43} = 0, \quad (32)$$

$$a_{44} = (1 - 2k)(R_7 + \alpha F_1). \quad (33)$$

The evolutionary game model composed of the smart medical industry structure shows that the evolutionary game of information technology providers, medical institutions, digital medical equipment providers, and medical regulators in the smart medical industry structure belongs to asymmetric evolutionary games. The equilibrium point containing mixed strategies must not be an evolutionary stable point, so only the equilibrium point of pure strategy is discussed here, and the results are shown in Table 3.

According to the eigenvalues of each equilibrium point in Table 3, equilibrium points E_2 (1, 1, 0, 1), E_3 (1, 0, 1, 1), E_5 (0, 1, 1, 1), E_9 (1, 1, 1, 0), E_{10} (1, 1, 0, 0), E_{11} (1, 0, 1, 0), E_{12} (1, 0, 0, 0), E_{13} (0, 1, 1, 0), E_{14} (0, 1, 0, 0), E_{15} (0, 0, 1, 0), and E_{16} (0, 0, 0, 0) have positive numbers in each eigenvalue, so these equilibrium points are not the evolutionary stable points of the smart medical industry structure.

The equilibrium points E_4 (1, 0, 0, 1), E_6 (0, 1, 0, 1), E_7 (0, 0, 1, 1), and E_8 (0, 0, 0, 1) all require certain conditions before they can all be less than zero, so these equilibrium points are not universal in their convergence to the evolutionary stability point and therefore cannot be used as the final evolutionary stability point for this study.

The eigenvalues λ_1, λ_2, λ_3, and λ_4 of the equilibrium point E_1 (1, 1, 1, 1) are all less than zero, so the equilibrium point E_1 (1, 1, 1, 1) is the evolutionary game stability of the smart medical industry structure. In other words, the future development trend of the wisdom medical industry structure is that under the background of supervision and management by medical regulators, information technology providers and digital medical equipment providers respectively provide the wisdom medical industry with the latest information technology and digital medical equipment to ensure the technical support of the wisdom medical industry, while medical institutions also provide the wisdom medical industry with the appropriate medical personnel and medical equipment to ensure that the wisdom medical industry talent and equipment needs.

3 Simulation analysis of evolutionary game model of smart medical industry structure

To verify the development trend of the smart medical industry structure, this study combined the evolutionary

Table 3: Development trend analysis of smart medical industry structure

Equilibrium	Eigenvalues $\lambda_1, \lambda_2, \lambda_3, \lambda_4$
E_1 (1, 1, 1, 1)	$-(R_1 + S_1 + T_1)$, $-(R_3 + S_4 + T_2)$, $-(R_5 + S_7 + T_3)$, $-(R_7 + \alpha F_1)$
E_2 (1, 1, 0, 1)	$-(R_2 - E_1 + S_2 + T_1)$, $-(R_4 - E_2 + S_5 + T_2)$, $R_5 + S_7 + T_3$, $-(R_7 + \alpha F_1)$
E_3 (1, 0, 1, 1)	$-(R_2 - E_1 + S_2 + T_1)$, $R_3 + S_4 + T_2$, $-(R_6 - E_3 + S_8 + T_3)$, $-(R_7 + \alpha F_1)$
E_4 (1, 0, 0, 1)	$-(R_2 - E_1 + S_2 + T_1)$, $R_4 - E_2 + S_5 + T_2$, $R_6 - E_3 + S_8 + T_3$, $-(R_7 + \alpha F_1)$
E_5 (0, 1, 1, 1)	$R_1 + S_1 + T_1$, $-(R_4 - E_2 + S_5 + T_2)$, $-(R_6 - E_3 + S_8 + T_3)$, $-(R_7 + \alpha F_1)$
E_6 (0, 1, 0, 1)	$R_2 - E_1 + S_2 + T_1$, $-(R_4 - E_2 + S_5 + T_2)$, $R_6 - E_3 + S_8 + T_3$, $-(R_7 + \alpha F_1)$
E_7 (0, 0, 1, 1)	$R_2 - E_1 + S_2 + T_1$, $R_4 - E_2 + S_5 + T_2$, $-(R_6 - E_3 + S_8 + T_3)$, $-(R_7 + \alpha F_1)$
E_8 (0, 0, 0, 1)	$R_2 - E_1 + S_2 + T_1$, $R_4 - E_2 + S_5 + T_2$, $R_6 - E_3 + S_8 + T_3$, $-(R_7 + \alpha F_1)$
E_9 (1, 1, 1, 0)	$-(R_1 + S_1 + T_1 - S_3)$, $-(R_3 + S_4 + T_2 - S_6)$, $-(R_5 + S_7 + T_3 - S_9)$, $R_7 + \alpha F_1$
E_{10} (1, 1, 0, 0)	$-(R_2 - E_1 + S_2 + T_1 - S_3)$, $-(R_4 - E_2 + S_5 + T_2 - S_6)$, $R_5 + S_7 + T_3 - S_9$, $R_7 + \alpha F_1$
E_{11} (1, 0, 1, 0)	$-(R_2 - E_1 + S_2 + T_1 - S_3)$, $R_3 + S_4 + T_2 - S_6$, $-(R_6 - E_3 + S_8 + T_3 - S_9)$, $R_7 + \alpha F_1$
E_{12} (1, 0, 0, 0)	$-(R_2 - E_1 + S_2 + T_1 - S_3)$, $R_4 - E_2 + S_5 + T_2 - S_6$, $R_6 - E_3 + S_8 + T_3 - S_9$, $R_7 + \alpha F_1$
E_{13} (0, 1, 1, 0)	$R_1 + S_1 + T_1 - S_3$, $-(R_4 - E_2 + S_5 + T_2 - S_6)$, $-(R_6 - E_3 + S_8 + T_3 - S_9)$, $R_7 + \alpha F_1$
E_{14} (0, 1, 0, 0)	$R_2 - E_1 + S_2 + T_1 - S_3$, $-(R_4 - E_2 + S_5 + T_2 - S_6)$, $R_6 - E_3 + S_8 + T_3 - S_9$, $R_7 + \alpha F_1$
E_{15} (0, 0, 1, 0)	$R_2 - E_1 + S_2 + T_1 - S_3$, $R_4 - E_2 + S_5 + T_2 - S_6$, $-(R_6 - E_3 + S_8 + T_3 - S_9)$, $R_7 + \alpha F_1$
E_{16} (0, 0, 0, 0)	$R_2 - E_1 + S_2 + T_1 - S_3$, $R_4 - E_2 + S_5 + T_2 - S_6$, $R_6 - E_3 + S_8 + T_3 - S_9$, $R_7 + \alpha F_1$

game model to simulate and analyze the development trend of the smart medical industry structure and also studied the factors that affect the development trend of the smart medical industry organization. Therefore, by using the hardware configuration of AMD Ryzen 5 4600H with Radeon Graphics and 16GB RAM, as well as the software configuration of Windows10 system and MATLAB R2016a as the experimental environment, the numerical simulation results calculated by MATLAB R2016a are analyzed.

3.1 Simulation analysis of the development trend of smart medical industry structure

First, the parameter initial value assumption is made for the evolutionary game model in the smart medical industry structure,where $R_1 = 15$, $R_2 = 10$, $R_3 = 12$, $R_4 = 7$, $R_5 = 13$, $R_6 = 8$, $R_7 = 5$, $S_1 = 5$, $S_2 = 2.5$, $S_3 = 2$, $S_4 = 4$, $S_5 = 2$, $S_6 = 1.5$, $S_7 = 5$, $S_8 = 2.5$, $S_9 = 2$, $E_1 = 5$, $E_2 = 3$, $E_3 = 5$, $T_1 = 3$, $T_2 = 2$, $T_3 = 3$, $\alpha = 0.5$, $F_1 = 5$, and the evolutionary game trends of information technology providers, medical institutions, digital medical equipment providers, and medical regulators included in the smart medical industry structure were simulated. In this way, the development trend of each component in the smart medical industry structure is analyzed, and the detailed information is shown in Figures 1–4.

From Figures 1–4, the final development trend of each component of the wisdom medical industry structure is that under the background of the strategy of supervision by the medical regulator, information technology providers and digital medical equipment providers provide the wisdom medical industry with the latest information technology and digital medical equipment to guarantee the technical support of the wisdom medical industry, while medical institutions also provide the wisdom medical industry with the corresponding medical talents and At the same time, medical institutions also provide the wisdom medical industry with the corresponding medical personnel and medical equipment to ensure the wisdom medical industry's talent and equipment needs, so that the wisdom medical industry structure in the future development of continuous improvement of wisdom medical technology level, and ultimately promote the overall development of the wisdom medical industry.

3.2 Analysis of influencing factors in the development of smart medical industry structure

The influencing factors of the overall development trend of the smart medical industry structure were analyzed, and the information technology providers, medical

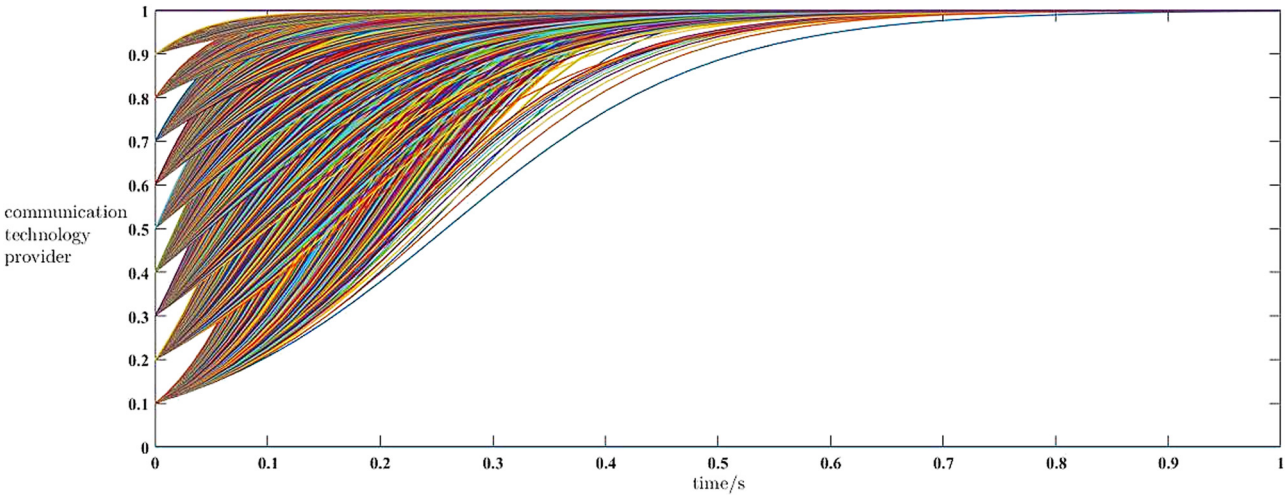

Figure 1: Evolutionary game trend of information technology providers.

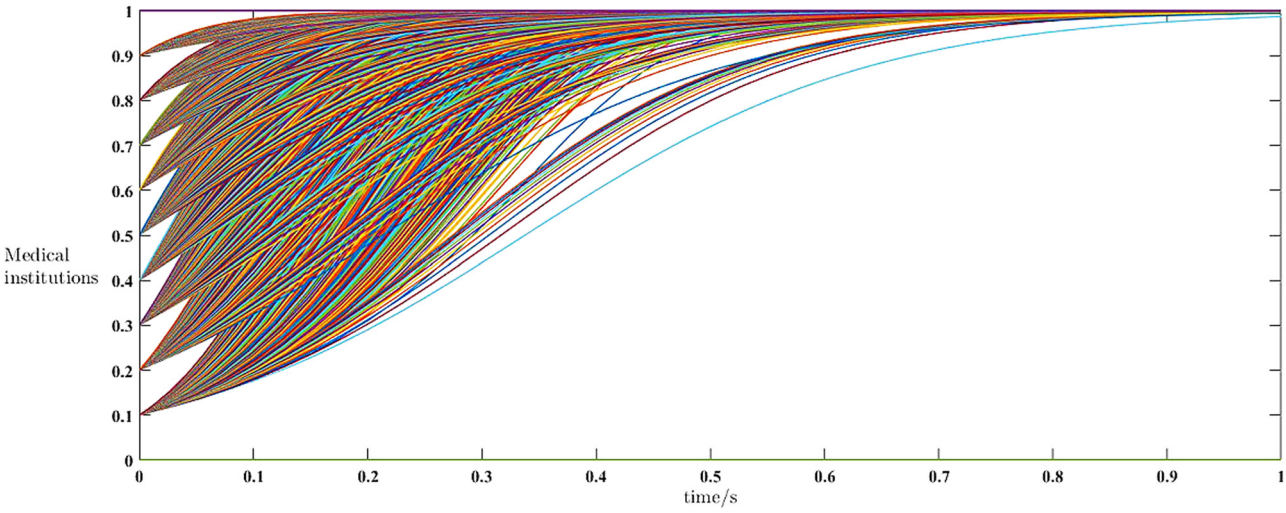

Figure 2: Evolutionary game trend of medical institutions.

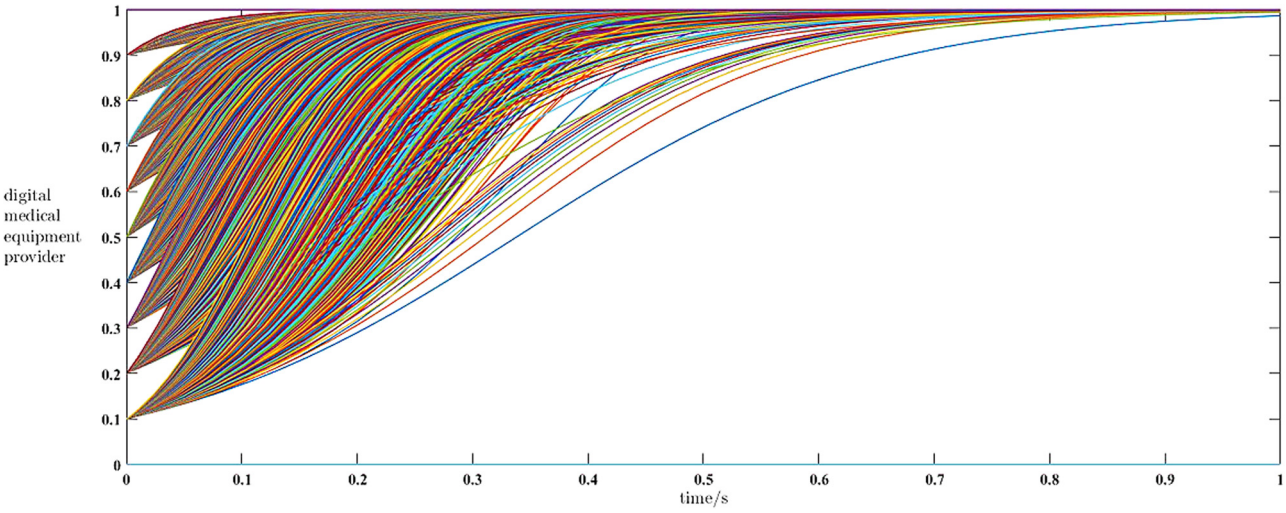

Figure 3: Evolutionary game trend of digital medical equipment providers.

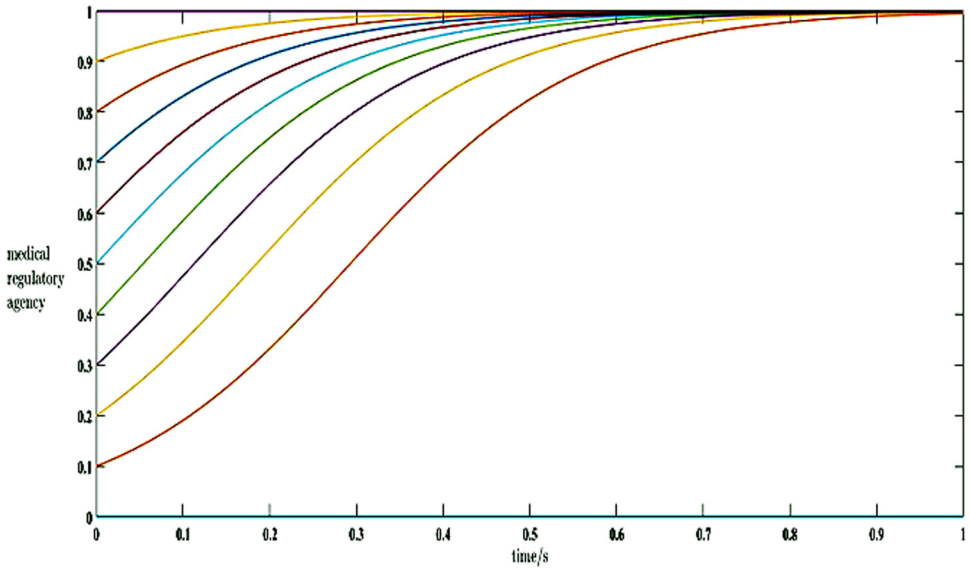

Figure 4: Evolutionary game trend of medical regulators.

institutions, and digital medical equipment providers in the smart medical industry structure without supervision and supervision by the medical regulatory agency were studied. The overall development trend and the simulation results are shown in Figures 5 and 6.

As can be seen from Figures 5 and 6, regardless of whether the medical regulatory agency supervises the information technology providers, medical institutions, and digital equipment providers in the smart medical industry structure, the overall development trend of the smart medical industry is that information technology providers, digital medical equipment providers, and medical institutions provide the corresponding resources for the smart medical industry to jointly guarantee the develop-

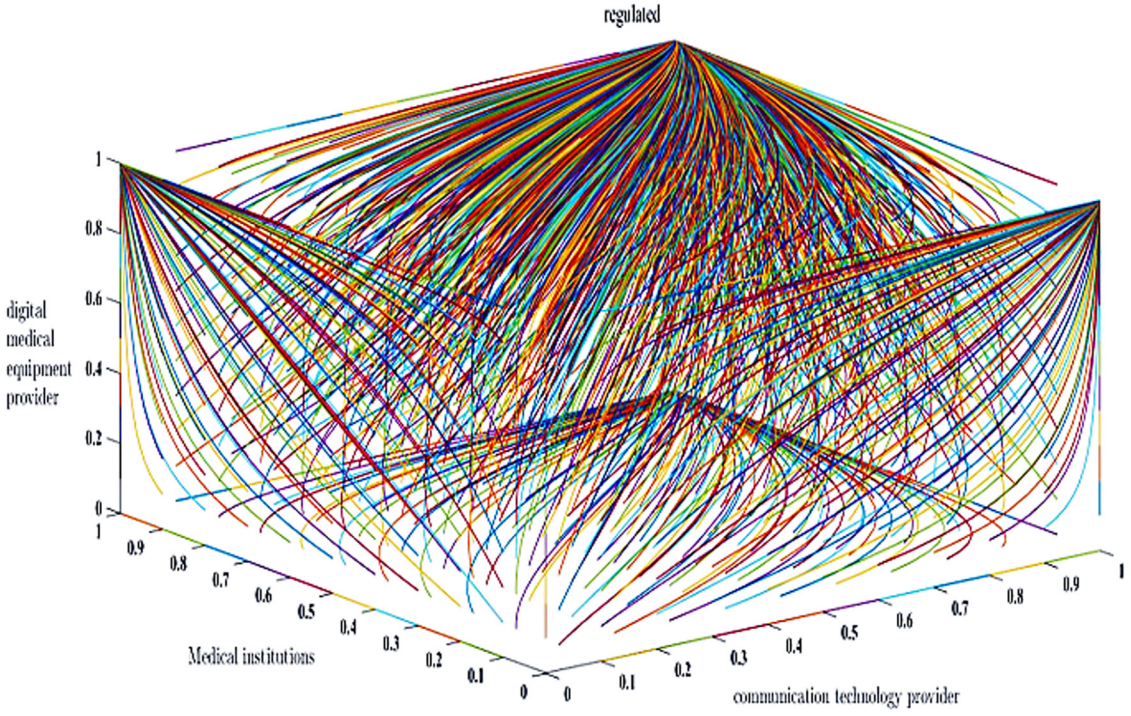

Figure 5: The overall development trend of the three parties in the smart medical industry structure under unregulated conditions.

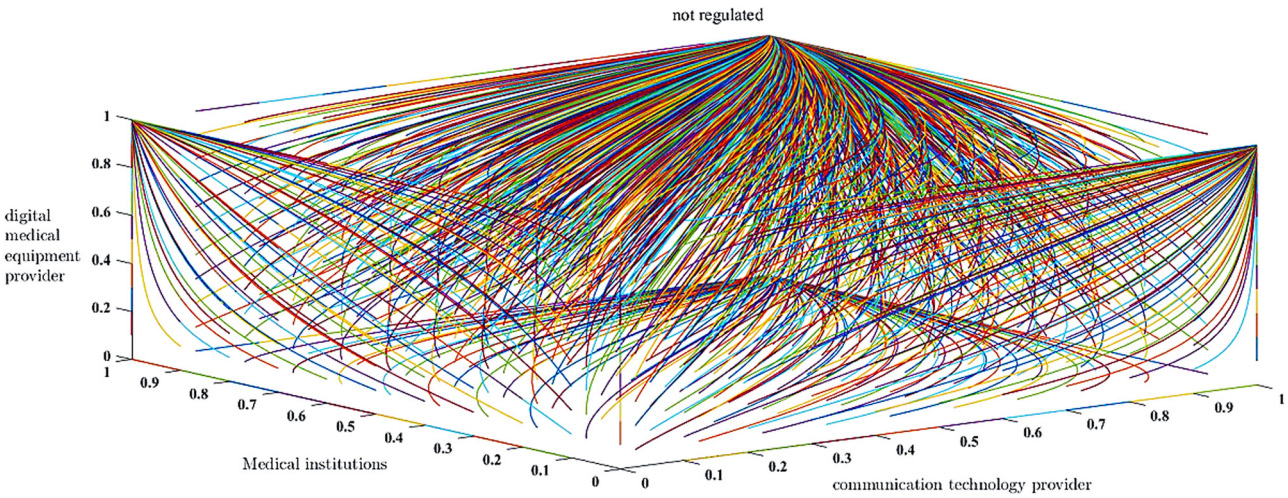

Figure 6: The overall development trend of the three parties in the smart medical industry structure under supervision.

ment of the smart medical industry, so that the overall smart medical industry will develop in the direction of the improvement of smart medical technology, and for the future progress of the smart medical industry Provide better preparation.

4 Conclusion

This article studies the future development trend of the smart medical industry through an evolutionary game analysis of information technology providers, medical institutions, digital medical equipment providers, and medical regulators in the smart medical industry in the context of the internet of things. Through the simulation results of MATLAB software, we can see that the overall development trend of the smart medical industry structure in the future is consistent with the development trend of each industrial structure. Under the strategic background of the supervision of medical regulatory agencies, information technology providers and digital medical equipment providers, respectively, provide the smart medical industry with the latest information technology and digital medical equipment to ensure the technical support of the smart medical industry. Provide corresponding medical talents and medical equipment for the smart medical industry to ensure the talent and equipment needs of the smart medical industry, so that the smart medical industry structure will continue to improve the level of smart medical technology in the future development and ultimately promote the overall development of the smart medical industry.

Author contributions: Luhong Zhang was responsible for writing the paper, Kai Zhou for reviewing and revising the paper, Weibin Zhao for constructing the model, and Huiyan Zhou for collecting the data.

Conflict of interest: The authors declare that there is no conflict of interest with any financial organizations regarding the material reported in this manuscript.

Data availability statement: The data that support the findings of this study are openly available in "Open Computer Science" at https://doi.org/10.1515/comp-2022-0247, reference number Luhong Zhang, Kai Zhou*, Weibin Zhao, and Huiyan Zhou. Research on the structure of smart medical industry based on the background of the internet of things, Open Computer Science, 2022(12), 1–9.

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