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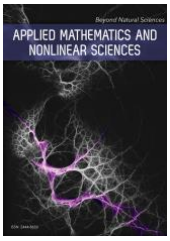

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A Study on Digital Technology Enabling Smart Transformation of Fitness for All

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Abstract

With the rapid development of information technology, digital technology provides a new way to realize national fitness activities. This study constructs an evaluation system for national fitness wisdom transformation using hierarchical analysis to explore the effectiveness of the current national fitness wisdom transformation. Secondly, it objectively analyzes the public service transformation of national fitness in the digital era through the rooted theory. It combines it with the evolutionary game method to construct a model of the influencing factors of national fitness wisdom transformation. Finally, taking City Z as an example, we carry out the actual measurement of national fitness wisdom transformation and explore the better path of its transformation through numerical simulation. The results show that the total score of the national fitness wisdom transformation in City Z is 95.96, and the transformation has achieved significant results. Finally, when the transformation and upgrading cost, service mode digitalization ability, data collection and analysis ability, and digital platform construction level are optimal, the effect of national fitness smart transformation tends to be 1. This study provides theoretical foundations and practical guidance for a smart transformation of national fitness.

Keywords: Hierarchical analysis; Digital technology; Rootedness theory; Evolutionary game method; National fitness.
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1 Introduction

Digital technology has promoted the transformation of public services, accelerated the process of scientific and technological revolution, brought great changes to social life, and created a precedent of public service change [1-2] on how to use digital technology to achieve the goal of modernization of public services for national fitness and improve the quality of public services, which is a brand new challenge for public service construction in the context of digital technology. In the original research activities, the analysis is mainly carried out from the level of intelligence and blockchain technology. Although the basic development ideas are indicated, however, the study is not in-depth at the level of the role of the mechanism and existing problems, and the development path is not clear [3-5]. From the overall level, the relevant research is in the exploratory stage, in the high development of digital technology today, how to open up a new path for the development of public services is particularly necessary. Currently, public sports facilities in many large cities are relatively perfect, but in some medium-sized cities and rural areas, the corresponding support is still immature. Although people pay more and more attention to physical exercise, there are still some people who are not very active in exercise, such as older adults and children [6-7]. The government of China has provided support for the construction of public services for national fitness in terms of policy and funding. However, there is still a gap compared with developed countries. In recent years, the sports industry has been highly developed, but not to the level of developed countries, and schools and communities should further improve the popularity of sports. With the deepening of the concept of health, the public attaches more and more importance to fitness, but there are still some people who form incorrect perceptions of physical exercise [8-9].

Literature [10] has accurately analyzed the evaluation model of sports resources efficiency in colleges and universities, and the results show that urban colleges and universities have the problems of excessive input of sports resources and low output rate of sports resources. Therefore, urban colleges and universities should make full use of the existing resources to enhance their social sports instructing power and, at the same time, improve the publicity of national fitness. Literature [11] empirically analyzed the construction of smart stadiums, and the results showed that through the development guidance and strategic adjustment of the construction of smart stadiums, the development power and sustainable operation capacity of stadiums were enhanced, and the development of national fitness was promoted. Literature [12] verified through experiments that the feature extraction method of national physical fitness data change based on data mining has high effectiveness in the process of practical application. It can better understand the changing trend of national physical fitness and put forward targeted suggestions for the optimization of national physical fitness and health. A study by [13] attempted to compare the ppVO(2) of the newly derived Fitness Registry and the Importance of Exercise: A National Database (FRIEND) registry equations with the conventional prediction equations in a clinical cohort of people undergoing cardiorespiratory fitness (CPX). Literature [14] found that the most important factor in the first level of college sports openness is the hardware factor of college sports resources, and the most important factor in the second level is the spatial layout of college sports resources. Literature [15] aims to study the informatization of national fitness public service construction in smart cities under the background of big data. Combining national adaptive behavior, data mining, and support vector machine (SVM), the objective function of statistical decision-making for data mining was established.

This article constructs the evaluation index system of national fitness wisdom transformation from five aspects: organization system, basic guarantee, safety guarantee, scene application, and transformation effectiveness, and measures them comprehensively after using a hierarchical analysis method for empowerment. In addition, the article integrates the rooted theory with the evolutionary game method to construct the influence factor model of national fitness wisdom transformation and explore the path of national fitness wisdom transformation. Finally, the four elements in the influence

model, namely, transformation and upgrading cost, service mode digitalization ability, data collection, and analysis ability, and digital platform construction level, are analyzed one by one to explore their influence on the effect of national fitness wisdom transformation.

2 Method

2.1 AHP-Based Measurement of Smart Transformation in Fitness for All

The basic process of hierarchical analysis is to list all the factors affecting the goal, then establish a hierarchical structure according to the relationship between the factors, then express the importance of the factors quantitatively, then calculate the importance weights of the factors in each level through the method of matrix, and finally analyze the layers to arrive at the importance weights of the bottom level that determines the final goal. The following steps are roughly divided:

1) Establishment of hierarchical structure model

The hierarchical analysis structure model diagram is shown in Figure 1 above. A complete understanding and knowledge of the problem is needed before the hierarchy is established so that all factors affecting the goals can be taken into account when analyzing the problem.

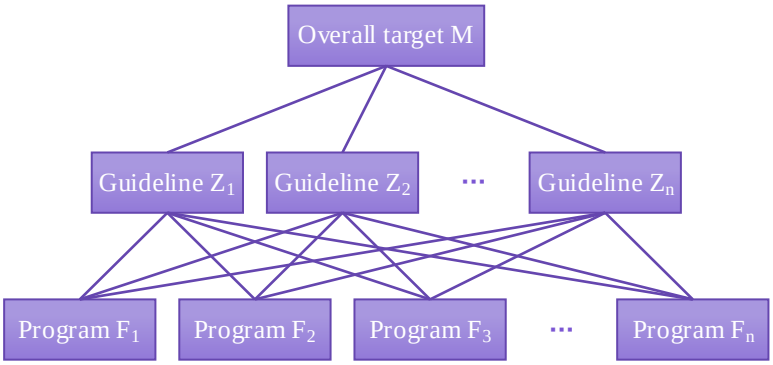


Figure 1. Hierarchical analysis structure model

2) Construction of Discriminant Matrix

The importance of each element of the next level to the previous level is different. In this level, to compare the degree of importance, through the construction of the matrix to reflect, assuming that the target element is M, the next level of each component and the target M has a dominant relationship with the $Z_1, Z_2, \cdots, Z_n$, respectively. The judgment matrix is shown in Table 1. The judgment matrix in a_{ij} indicates that for M, Z_i on the relative importance of Z_j quantitative value, and $a_{ij} > 0, a_{ij} \cdot a_{ji} = 1$, $a_{ij} = 1(i = j)$.

Table 1. Judgment matrix

M	Z_1	Z_2	$\cdots$	Z_n
Z_1	a_{11}	a_{12}	$\cdots$	a_{1n}
Z_2	a_{21}	a_{22}	$\cdots$	a_{2n}
$\cdots$	$\cdots$	$\cdots$	$\cdots$	$\cdots$
Z_n	a_{n1}	a_{n2}	$\cdots$	a_{nn}

3) Determine the weight vector of the matrix

The relative weight of each element is solved by the square root method by first calculating the product of the elements of each layer:

$$b_i = \prod_{j=1}^{n} a_{ij} \tag{1}$$

Find the nst power root of the equation, i.e.:

$$P_i = \sqrt[n]{b_i} \quad (i = 1, 2, \cdots, n) \tag{2}$$

Regularize the phase quantity $P = \left(P_1, P_2, \cdots, P_n\right)^T$, i.e:

$$W_i = \frac{P_i}{\sum_{k=1}^{n} P_k} \quad (i = 1, 2, \cdots, n) \tag{3}$$

Then $W = \left(W_1, W_2, \cdots, W_n\right)^T$ is the required weight vector.

4) Judgment matrix consistency test

Due to the existence of fuzzy elements, to achieve all the characteristic roots of the judgment matrix to meet the requirements is to test the matrix consistency problem. First of all, the maximum characteristic root of the judgment matrix A is required $\lambda_{\max}$, W is the feature vector. That is:

$$\lambda_{\max} = \sum_{i=1}^{n} \frac{(AW)_i}{nW_i} \quad (i = 1, 2, \cdots, n) \tag{4}$$

This allows the calculation of the consistency indicator $C.I.$:

$$C.I. = \left(\lambda_{\max} - n\right) / (n-1) \tag{5}$$

5) Hierarchical total sorting

After the completion of all sub-criteria sorting and then sorting the total criteria, the superposition of the weights between the layers can be derived from the total sorting combination of weight values. The calculation formula is as follows:

$$f_m = \sum_{i=1}^{n} z_i f_m^i \tag{6}$$

6) Hierarchical total order consistency test

The total ordering consistency test needs to be calculated sequentially from top to bottom to arrive at the total ordering from the bottom level to the top level. The value of the ordering of the bottom level to the top level is:

$$f_j = \sum_{i=1}^{n} z_i f_j^i \quad (j = 1, 2, \cdots, m) \tag{7}$$

This test can be used to find out the size of the rating value f_j of each program, and the highest rating is the best program. Otherwise, it is necessary to re-establish the judgment matrix and calculate again according to the above steps.

2.2 Mining Transformational Factors Based on Rootedness Theory

The rooted theory is a qualitative research method, which means that the researcher does not assume a theory before starting and starts directly from observation. In the process of collecting and analyzing empirical data, they continuously generalize and construct a theory on this basis.

The classical rooted theory is shown in Figure 2. The process and rules of the research are as follows:

1) The researcher does not need research preparation and assumptions at the beginning and can have a research direction but never set research questions in advance.

2) Using an in-depth interview method and participant observation method, theoretical sampling is used to collect empirical data on the research subjects and find the relationality and difference between the research subjects.

3) Organize and code the data based on the interview transcripts, and the coding includes substantive and theoretical coding.

4) Writing memos throughout the data collection and coding process to record the researcher's immediate thoughts throughout the research process. The theoretical framework was created through the refinement of integration concepts and sorting out integration logic during the continuous collection of recorded data.

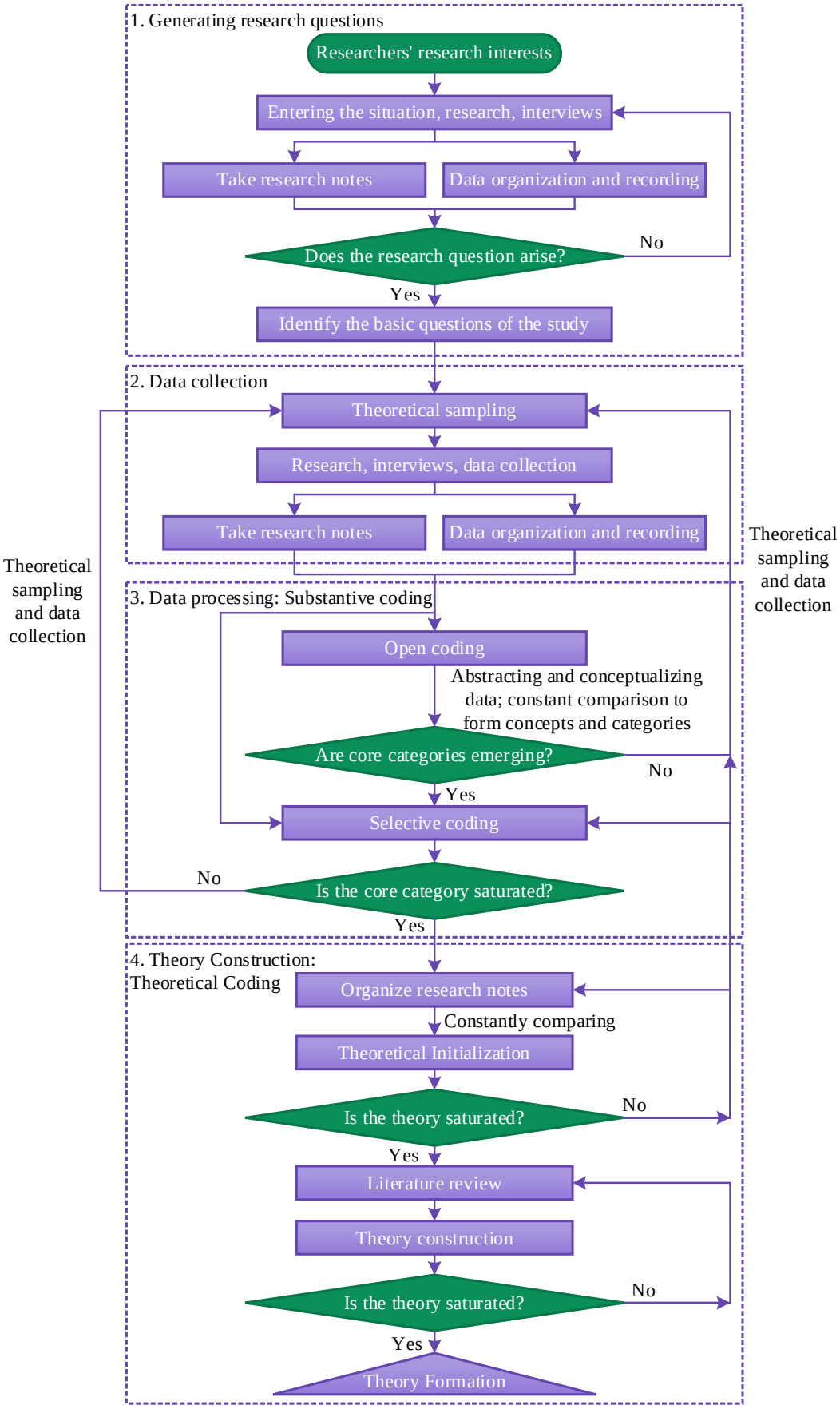


Figure 2. Classic root theory coding process

Within this framework, rooted theory research has been applied to a variety of fields, including medical science, psychology, and social work, but a large number of problems have emerged. Subsequently, a more procedural level and a more systematic and rigorous coding process emerged for Zagan Theory. Open coding: Similar to the open coding process of classical rooting theory, it requires extracting a number of categories from the textual material, searching for the attributes of the categories, and dimensionalizing them. Primary coding establishes primary and secondary categories and organizes the secondary categories around the primary categories according to a canonical model. In the canonical model, the five main categories: causal conditions, environment, intervening conditions, action interactions, strategies, and consequences are referred to, and a number of more solid main categories are identified. This rigorously programmed and rooted theory is applied and recognized by a wide range of social scientists engaged in qualitative research.

The author utilized the data collected from the interviews to conduct open coding, principal axis coding, and selective coding using the rooting theory, and the way of constantly comparing theories, clarifying the categories, and ultimately forming theories can effectively explore the influencing factors of the effect of the transformation of national fitness wisdom.

2.3 Fitness for All Smart Transformation and Upgrading Evolutionary Game

1) Basic model of an evolutionary game

The basic architecture of a typical evolutionary game (denoted by G) consists of a set of population participants, a set of population strategies, and a population payment matrix. Let it be:

$$G := \{N; \Phi; U\} \tag{8}$$

Where: N is the set of population participants, if G contains n populations, then $N = \{1, 2, \cdots, I, \cdots, n\}, i \in N; \Phi$ is the set of population strategies, $\{S_1, S_2, \cdots, S_1, \cdots, S_n\}$, S_i is the set of methods for species i, U is the set of population payments, $U = U_1, U_2, \cdots, U_I, \cdots, U_n$, U_i is the set of payments for species i.

Based on Eq. (8), for a generic three-party n-strategy evolution game, when its payment parameters are symmetric, the game is a symmetric evolution game, at which time all the participants in the game are aware of each other's preferences, and vice versa if the payment parameters are not symmetric, the game is an asymmetric evolution game, at which time the degree of information the various groups have about each other will not be symmetric.

2) Evolutionarily stable strategies and evolutionarily stable equilibria

Evolutionarily stable strategies are used to characterize the stable state of an evolutionary game system at a certain equilibrium. When some pure strategy of the system is an ESS, it can resist the invasion of any small group containing mutation strategies, i.e., the group with ESS has higher stability in the defined strategy set Φ. Assuming two pure strategies of the system $s_1, s_2 \in \Phi$, and $s_1 \neq s_2$, s_1 is the ESS of the system if there always exists $\kappa \in (0,1)$ such that the following equation holds.

$$f\left(s_1, \kappa' s_1 + (1-\kappa') s_2\right) > f\left(s_2, \kappa' s_1 + (1-\kappa') s_2\right) \#(2), \text{ where } \forall \kappa' \in (0, \kappa) \tag{9}$$

$f(\cdot)$ is denoted as the fitness function of the system under a certain strategy selection scenario shown in Eq. (9), which portrays the mapping relationship between strategy and fitness, similar to the payment function in classical game theory. In contrast, its calculation result denotes the specific fitness value (which can be interpreted as the reproduction rate). In the following analysis for specific evolutionary game types, this fitness value is expressed as the payment of the system in a certain strategy selection situation, thus forming the payment distribution parameter matrix of the system. As for the specific expression form of the $f(\cdot)$-function, it needs to be determined according to the given payment function in the actual evolutionary game scenario.

3) Replicator dynamics model

The replicator dynamics model is a core dynamics mechanism in evolutionary game theory, which can be well used to describe the changing trend of group behavior of finite rational individuals. If the probability or proportion of individuals of population i choosing a strategy s in the strategy set S_i in each round of the sub-repeated evolutionary game is $x_i(t)$, and the corresponding expected payoff is $f_i(s;x;t)$, and the average anticipated payoff of population i at this time is $f_{ave}(s;t)$, then the replicator dynamics model for choosing strategy s is:

$$\frac{dx_i(t)}{dt} = x_i(t)\left[f_i(s;x;t) - f_{ave}(s;t)\right] \tag{10}$$

From equation (10) it can be seen that the differential of the probability of choosing a strategy (or the proportion of individuals) within the population is proportional to the value of that probability and the difference between the expected payment for choosing that strategy and the average anticipated payment of the population at this point. Thus, when the right-hand side of the equation is equal to 0, it means that the proportion of strategy s in the population remains unchanged and will become a spontaneous ESS formed by the system after a long period of evolution. It is important to note that Eq. (10) addresses the pattern of change in the probability (or proportion of individuals) that a given pure strategy s_i will be selected during each bordereau, i.e., the law of evolution for $x_i(t)$. Eq. (10) shows that if an individual's payment (or return) for choosing a pure strategy s_i is less than the group average payment (or return), the growth rate of the number of individuals (or probability) for choosing that pure strategy s_i is negative, and vice versa. If the two are equal, it indicates that the proportion of individuals (or likelihood) choosing that pure strategy s_i remains constant, is maintained at a stable level, and leads to a dynamic equilibrium in the system. In this equilibrium, no individual would be willing to unilaterally change their chosen strategy. In fact, if for a mixed strategy, according to the study, it is not possible to be an ESS for an asymmetric multi-group evolutionary game system, i.e., the system is not likely to spontaneously reach a long-term evolutionarily stable equilibrium state at the mixed strategy.

4) Three-party evolutionary game models

For the generic three-group, two-strategy evolutionary game, the three parties in it are denoted by groups A, B and C, respectively. The strategy sets of these three groups all contain a pair of mutually exclusive pure strategies, i.e., the strategy sets of groups A, B, and C are assumed to be respectively:

$$\Phi_{SA} = \left\{S_{A1}, S_{A2}\right\}, \Phi_{SB} = \left\{S_{B1}, S_{B2}\right\}, \Phi_{SC} = \left\{S_{C1}, S_{C2}\right\} \tag{11}$$

S_{A1} vs. S_{A2}, S_{B1} vs. S_{B2}, S_{C1} vs. S_{C2} denote a pair of mutually exclusive strategies, respectively, and a pair of mutually exclusive pure strategies. The probabilities (or proportions of individuals) that pairs of mutually exclusive strategies S_{A1} vs. S_{A2}, S_{B1} vs. S_{B2}, S_{C1} vs. S_{C2} will be selected in groups A, B and C, respectively, in each round of the sub-repeated game of the evolutionary game system consisting of groups A, B and C are x and $1-x, y$ and $1-y, z$ and $1-z$, where $x, y, z \in [0,1]$. Thus, the decision space of this generic three-party, two-strategy evolutionary game system of this class can be defined as $\Psi = [0,1]\times[0,1]\times[0,1]$, which denotes a region of unit cube space in the xyz coordinate system, where each coordinate value at any point in the area is non-negative, i.e., $\Psi = (x, y, z) \mid x \in [0,1], y \in [0,1], z \in [0,1]$.

$$\Phi_1 = \left(S_{A1}, S_{B1}, S_{C1}\right), \Phi_2 = \left(S_{A1}, S_{B1}, S_{C2}\right),$$
$$\Phi_3 = \left(S_{A1}, S_{B2}, S_{C1}\right), \Phi_4 = \left(S_{A1}, S_{B2}, S_{C2}\right),$$
$$\Phi_5 = \left(S_{A2}, S_{B1}, S_{C1}\right), \Phi_6 = \left(S_{A2}, S_{B1}, S_{C2}\right),$$
$$\Phi_7 = \left(S_{A2}, S_{B2}, S_{C1}\right), \Phi_8 = \left(S_{A2}, S_{B2}, S_{C2}\right).$$

Assume that the i st strategy pair Φ_i corresponds to a payoff combination of $\left(a_I, b_I, c_i\right)$, where: $i = 1, 2, \cdots, 8$. Therefore, the payoff matrix (payoff matrix) of the system is shown in Table 2.

Table 2. System payoff matrix

(x, y, z)					
				$S_{A1}(x)$	$S_{A2}(1-x)$
C	$S_{C1}(z)$	B	$S_{B1}(y)$	$\left(a_1, b_1, c_1\right)$	$\left(a_2, b_2, c_2\right)$
C			$S_{B2}(1-y)$	$\left(a_3, b_3, c_3\right)$	$\left(a_4, b_4, c_4\right)$
C	$S_{C2}(1-z)$	B	$S_{B1}(y)$	$\left(a_5, b_5, c_5\right)$	$\left(a_6, b_6, c_6\right)$
C			$S_{B2}(1-y)$	$\left(a_7, b_7, c_7\right)$	$\left(a_8, b_8, c_8\right)$

Copy the power system for:

$$\begin{cases} \dot{x} = x(1-x)\left(\chi_1 yz + \chi_2 y + \chi_3 z + \chi_4\right) \\ \dot{y} = y(1-y)\left(\chi_5 xz + \chi_6 x + \chi_7 z + \chi_8\right) \\ \dot{z} = z(1-z)\left(\chi_9 xy + \chi_{10} x + \chi_{11} y + \chi_{12}\right) \end{cases} \tag{12}$$

Among them:

$$\chi_1 = a_1 - a_2 - a_3 + a_4 - a_5 + a_6 + a_7 - a_8, \chi_2 = a_2 - a_4 - a_6 + a_8,$$
$$\chi_3 = a_3 - a_4 - a_7 + a_8, \chi_4 = a_4 - a_8, x_5 = b_1 - b_2 - b_3 + b_4 - b_5 + b_6 + b_7 - b_8, x_6 = b_2 - b_4 - b_6 + b_8,$$
$$\chi_7 = b_5 - b_6 - b_7 + b_8, x_8 = b_6 - b_8, x_9 = c_1 - c_2 - c_3 + c_4 - c_5 + c_6 + c_7 - c_8, \chi_{10} = c_3 - c_4 - c_7 + c_8,$$
$$\chi_{11} = c_5 - c_6 - c_7 + c_8, \chi_{12} = c_7 - c_8.$$

Further, the corresponding Jacobi matrix for this model can be calculated as:

$$J=\begin{bmatrix} \frac{\partial F(x)}{\partial x} & \frac{\partial F(x)}{\partial y} & \frac{\partial F(x)}{\partial z} \\ \frac{\partial F(y)}{\partial x} & \frac{\partial F(y)}{\partial y} & \frac{\partial F(y)}{\partial z} \\ \frac{\partial F(z)}{\partial x} & \frac{\partial F(z)}{\partial y} & \frac{\partial F(z)}{\partial z} \end{bmatrix}=\begin{bmatrix} R_{11} & R_{12} & R_{13} \\ R_{21} & R_{22} & R_{23} \\ R_{31} & R_{32} & R_{33} \end{bmatrix} \tag{13}$$

Among them:

$$R_{11}=(1-2x)\left(\chi_4+\chi_2 y+\chi_3 z+\chi_1 yz\right), R_{12}=x(1-x)\left(\chi_2+\chi_1 z\right), R_{13}=x(1-x)\left(\chi_3+\chi_1 y\right),$$
$$R_{21}=y(1-y)\left(\chi_6+\chi_5 z\right), R_{22}=(1-2y)\left(\chi_8+\chi_6 x+\chi_7 z+\chi_5 xz\right), R_{23}=y(1-y)\left(\chi_7+\chi_5 x\right),$$
$$R_{31}=z(1-z)\left(\chi_{10}+\chi_9 y\right), R_{32}=z(1-z)\left(\chi_{11}+\chi_9 x\right), R_{33}=(1-2z)\left(\chi_{12}+\chi_{10} x+\chi_{11} y+\chi_9 xy\right).$$

In fact, the replicated dynamical system equations do not have any other mixed-strategy evolutionary stabilizing equilibrium points, but only 8 sets of purely strategy-internal equilibrium points, i.e., $E_1(0,0,0), E_2(0,0,1), E_3(0,1,0), E_4(0,1,1), E_5(1,0,0)$, $E_6(1,0,1), E_7(1,1,0), E_8(1,1,1)$, which happen to be located at the 8 vertices of the system's decision space cube.

Based on the above analysis, substituting the equilibrium points $E_1 \sim E_8$ times into the Jacobi matrix shown in Eq. (13) yields the computational statistics of its determinant det, trace tr, and eigenvalue $\left(\lambda_1, \lambda_2, \lambda_3\right)$. At these equilibrium points, ESS may be achieved and eventually reach the long-term system evolution stable equilibrium.

3 Results and Discussion

3.1 Constructing and Analyzing the Evaluation System of Smart Transformation of Fitness for All

3.1.1 Establishment and empowerment of the indicator system

In this study, the construction of the evaluation index system of national fitness wisdom transformation was carried out in two rounds and the data recovered through the two rounds were analyzed. The weights calculated by the hierarchical analysis method after eliminating the indicators with the mean value less than 4.0 and the coefficient of variation greater than 0.20 were eliminated. At the same time, then the constructed national fitness wisdom transformation evaluation index system was tested for reliability, 500 questionnaires were issued to the citizens of City Z, and 478 valid questionnaires were obtained. The final questionnaire validity rate was 95.6%, and the recovered pre-questionnaire data were tested for reliability: the reliability was 0.93, which indicated that the reliability was good. The evaluation index system of national fitness intelligence transformation is shown in Table 3. The evaluation system finally covers 5 first-level indicators, 12 second-level indicators, and 22 third-level indicators.

Table 3. National Fitness Intelligence Transformation Evaluation Index system

Primary indicator	Weight	Secondary indicator	Weight	Tertiary indicator	Weight
Organizational system	24.77%	Organizational leadership	43.76%	Construction of leadership mechanism	5.39%
				Organization construction	5.45%
		Institutional standard	56.24%	Planning design	6.98%
				Institutional norms	3.53%
				Standard norms	3.42%
Basic protection	30.48%	Basic network facilities guarantee	67.09%	Urban 5G development	4.79%
				Urban fixed broadband download rate	5.40%
				Urban Internet penetration	10.26%
		Basic data protection	19.72%	Local government data open index	6.01%
		Infrastructure protection	13.19%	Urban digital platform	4.02%
Safety guarantee	15.34%	Network security	58.47%	Urban digital network security index	8.97%
		Governance Security	41.53%	Emergency security system	6.37%
Scenario application	18.21%	Government service	43.11%	Online coverage	1.45%
				Online integration	1.31%
				Government information disclosure	2.23%
				Interactive channel construction	1.72%
				Decision platform construction	1.14%
		Public service	41.63%	Application construction	7.58%
		Market supervision	15.26%	Video monitoring network rate	2.78%
Transformation effect	11.20%	Government satisfaction	22.50%	Construction of the department of sports administration satisfaction	0.97%
				Data service satisfaction	1.55%
		Public satisfaction	77.50%	Good or bad evaluation of overall satisfaction	8.68%

3.1.2 Analysis of the results of the evaluation of the smart transformation of fitness for all

The data sources that correspond to the combined evaluation indicators are extracted according to the digital transformation evaluation system of national fitness governance constructed above. After obtaining the basic data scores, combined with the weights of the evaluation indicators of the national fitness wisdom transformation that have been calculated using the hierarchical analysis method, the scores of the three-level indicators were calculated in detail, and the specific formula was: corresponding to the three-level indicator scores = (corresponding to the indicator data scores/corresponding to the indicator measurements)*indicator weights*100 (points), and the specific scores of the three-level indicators are shown in Table 4. The total score of Smart Transformation of National Fitness in City Z is 95.96 points after calculation. In terms of the total score, the smart transformation of national fitness in City Z has achieved remarkable results.

Table 4. The national fitness intelligence transformation rating level tertiary indicators score

Primary indicator	Secondary indicator	Tertiary indicator	Tertiary indicator score	Result of the non-quantization
Organizational system	Organizational leadership	Construction of leadership mechanism	7.27	1.00
		Organization construction	5.41	1.00
	Institutional standard	Planning design	1.33	0.96
		Institutional norms	1.18	0.98
		Standard norms	1.25	0.77
Basic protection	Basic network facilities guarantee	Urban 5G development	1.92	0.82
		Urban fixed broadband download rate	2.66	0.70
		Urban Internet penetration	10.08	1.00
	Basic data protection	Local government data open index	4.14	0.95
	Infrastructure protection	Urban digital platform	5.11	0.95
Safety guarantee	Network security	Urban digital network security index	4.4	0.69
	Governance Security	Emergency security system	6.49	0.81
Scenario application	Government service	Online coverage	2.47	0.87
		Online integration	3.71	1.00
		Government information disclosure	5.01	0.68
		Interactive channel construction	6.76	0.76
		Decision platform construction	4.25	0.70
	Public service	Application construction	3.05	0.95
	Market supervision	Video monitoring network rate	1.3	0.84
Transformation effect	Government satisfaction	Construction of the department of sports administration satisfaction	3.15	0.79
		Data service satisfaction	5.11	0.97
	Public satisfaction	Good or bad evaluation of overall satisfaction	9.91	1.00

While obtaining the scores of the third-level indicators, the scores of the first-level and second-level indicators are also re-grouped and calculated. The results after dimensionless quantization of the indicators at all levels are derived respectively by combining the standard scores of the indicators at all levels in order to lay a good foundation for the subsequent in-depth evaluation of the situation of the national fitness wisdom transformation of Z City, the scores of the first-level indicators are shown in Table 5. The scores of the second-level indicators are shown in Table 6.

The lowest score of scene application of national fitness wisdom transformation in City Z, the result after dimensionless quantization is only 0.70, indicating that the scene application of national fitness governance wisdom transformation in City Z is not strong. The safety and security scores are higher, with the results reaching 0.85 after dimensionless quantization, respectively. This indicates that the safety and security level of the smart transformation of national fitness governance in City Z is high. The ratings of organizational system, basic guarantee, and transformation effectiveness are extremely high, with the results reaching 0.88, 0.89, and 0.92 after dimensionless quantification, indicating that the organizational system of national fitness governance wisdom transformation in City Z is perfect,

the construction effect is excellent, the overall construction direction error is extremely small, and the public's actual sports needs are met to an extremely high degree.

In the dimension of the organizational system, the dimensionless results of the two secondary indicators of organizational leadership and institutional standards are 0.83 and 0.80, respectively, indicating that the level of managerial leadership and the construction of institutional standards have reached the transformation standards. In the dimension of basic security, the three secondary indicators of basic network facilities security, basic data security, and basic platform security are 0.82, 0.90, and 1.00, respectively, after dimensionless quantization, indicating that the construction of basic network facilities in Wuxi is better, the basic data security situation is perfect, and the basic platform security situation is excellent. In the dimension of safety and security, the two secondary indicators of network security and governance security are 0.84 and 0.92, respectively, after dimensionless quantization, indicating that the overall network security situation in City Z is better and the governance security index is high. In the dimension of scenario application, the dimensionless results of the three secondary indicators of government service, public service, and market supervision are 0.84, 0.77, and 0.90, respectively, indicating that there is still room for improvement in the construction of government service application and market supervision application and in the construction of public service application in Z city. In the dimension of transformation effectiveness, the dimensionless results of the two secondary indicators of government satisfaction and public satisfaction are 1.00 and 0.83, respectively, which indicates that the effectiveness of the smart transformation of national fitness in City Z is satisfactory to both the public and the government.

Table 5. The national fitness intelligence transformation rating level primary indicators score

Primary indicator	Primary indicator score	Standard score for primary indicators	Result of the non-quantization
Organizational system	20.08	22.53	0.88
Basic protection	17.05	18.45	0.89
Safety guarantee	15.40	17.34	0.85
Scenario application	11.06	15.6	0.70
Transformation effect	24.21	26.08	0.92

Table 6. The national fitness intelligence transformation rating level secondary indicators score

Primary indicator	Secondary indicator	Secondary indicator score	Standard score for secondary indicators	Result of the non-quantization
Organizational system	Organizational leadership	4.1	5.6	0.83
	Institutional standard	7.16	8.31	0.80
Basic protection	Basic network facilities guarantee	4.47	5.34	0.82
	Basic data protection	7.51	9.14	0.90
	Infrastructure protection	18.28	20.2	1.00
Safety guarantee	Network security	7.51	9.12	0.84
	Governance Security	8.44	8.66	0.92
Scenario application	Government service	7.62	8.54	0.84
	Public service	2.24	5.11	0.77
	Market supervision	3.49	4.83	0.90
Transformation effect	Government satisfaction	5.67	6.62	1.00
	Public satisfaction	7.12	8.53	0.83

3.2 Analysis of factors influencing the smart transformation of fitness for all

3.2.1 A model of factors influencing the smart transformation of fitness for all

Based on the local scenario of the transformation and upgrading of national fitness public services in the digital era embedded in the rooted theory, this paper firstly identifies eight key categories affecting the transformation and upgrading of national fitness public services through open coding. It defines them as the level of technological innovation, innovation of operation mode, level of innovation toughness, data collection capacity, digital platform construction, professional talent training, digitization of service mode, and science and technology research and development, respectively. Input. Secondly, all the categories were categorized into three main categories, namely, innovation-driven factors, digital production factors, and traditional resources factors, by means of principal axis coding, and the contents of each sub-category within the main categories were described based on the interview results. Furthermore, the internal logical relationship between the main categories was determined through selective coding to construct a theoretical model of the relationship between the factors influencing the transformation and upgrading of public services for national fitness in the digital era. To determine if the research results have reached saturation, the theoretical model is tested for theoretical saturation. By synthesizing the above steps, the theoretical model of the factors that influence the transformation and upgrading of national fitness wisdom is constructed, as shown in Figure 3.

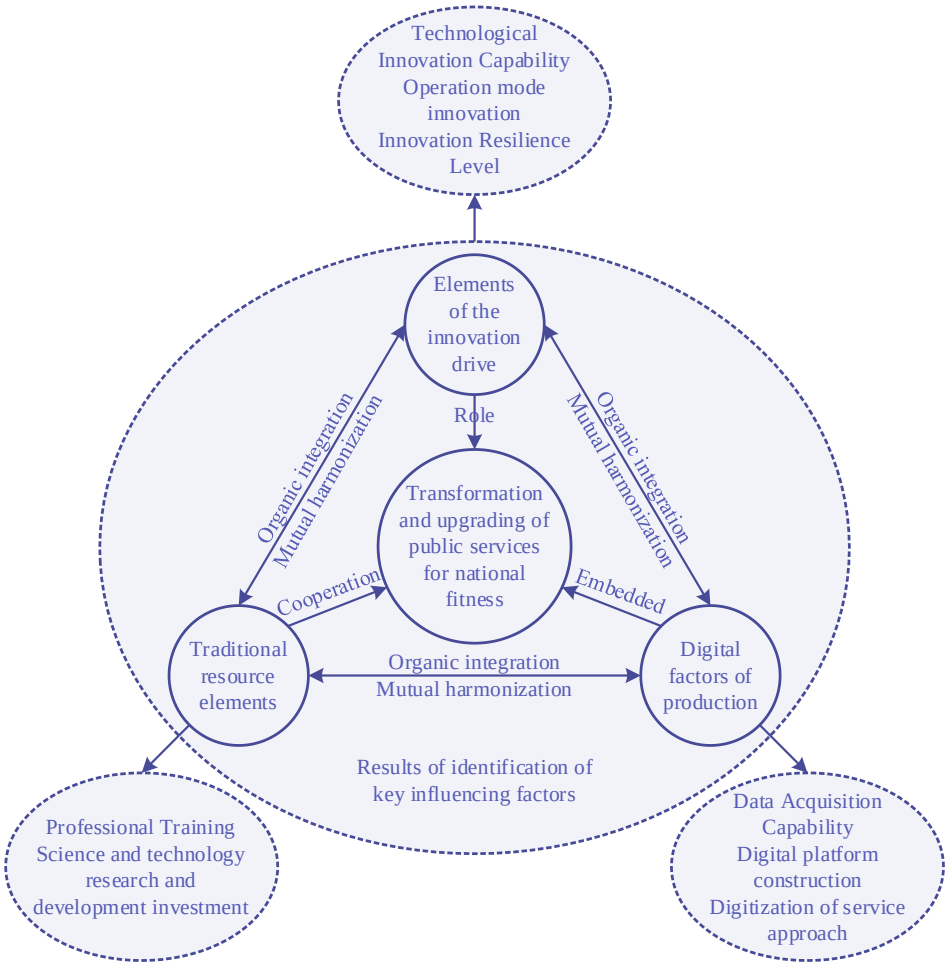


Figure 3. Model of influencing factors for transformation of National Fitness Wisdom

3.2.2 Analysis of factors influencing the smart transformation of fitness for all

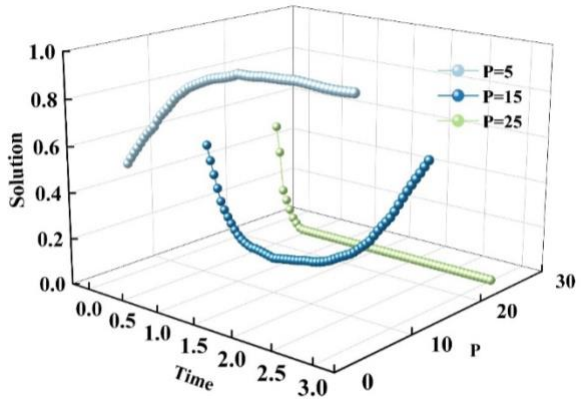
In order to more intuitively analyze the influence of various digital production factors on the transformation and upgrading of national fitness wisdom, this subsection will combine the relevant literature and the actual situation of national fitness wisdom transformation and upgrading of the evolutionary game model to assign appropriate values, and numerical simulation using the Matlab2021b software in order to demonstrate the replication of the dynamic system in the transformation and upgrading of the change in cost and the ability of digitalization of the service mode, data collection and analysis ability and digital platform construction level of each key element on the national fitness intelligent transformation and upgrading. The effects of transformation and upgrading cost, service mode digitization ability, and data collection and analysis ability on the smart transformation of national fitness are shown in Fig. 4 and Figs. (a) to (d) show the effects of transformation cost, digitization ability, data collection ability, and digital platform construction level on the smart transformation of national fitness, respectively.

From Figure (a), it can be seen that the probability of national fitness smart transformation changes when the transformation and upgrading cost (P) changes. Specifically, when the value of transformation and upgrading cost P gradually increases, the probability of national fitness intelligent transformation and upgrading will become smaller and smaller. When the value of P is close to 25, the convergence speed of not carrying out intelligent transformation and upgrading will become faster and faster and finally converge to 0. It can be seen that the cost of transformation and upgrading is the key factor that affects and restricts the intelligent transformation of national fitness.

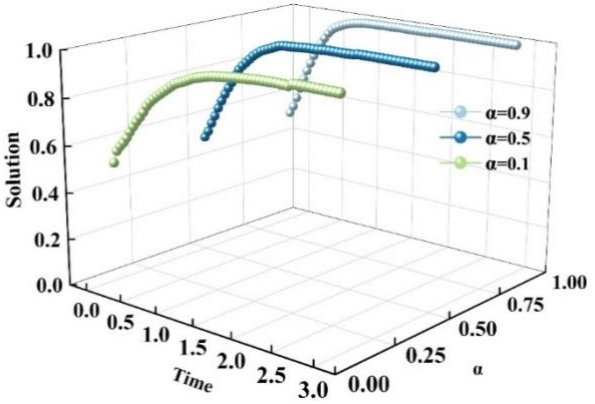
In order to analyze the impact of the dynamic change of the digital capacity coefficient α of the service mode on the evolutionary game process and results of the national fitness wisdom transformation, under the premise of keeping the other parameters unchanged, simulation analyses are carried out by assigning $\alpha = 0.9, 0.5, 0.1$, respectively, in order to more intuitively show the role of the change of the digital capacity of the service mode in the influence of the wisdom transformation of the national fitness. As shown in Fig. (b), when the service mode digitization capability α is gradually increased, the convergence speed of the work related to the upgrading of the national fitness wisdom transformation becomes faster and faster and finally converges to 1.

In order to analyze the impact of the dynamic change of the data collection and analysis capability coefficient β on the evolutionary game process and results of the national fitness wisdom transformation, the simulation analysis is carried out by assigning $\beta = 0.9, 0.5$, and 0.1, respectively, under the premise of keeping other parameters unchanged. As shown in Fig. (c), when the data collection capacity β is gradually increased, the convergence speed of the work related to the intelligent transformation and upgrading of national fitness becomes faster and faster and finally converges to 1.

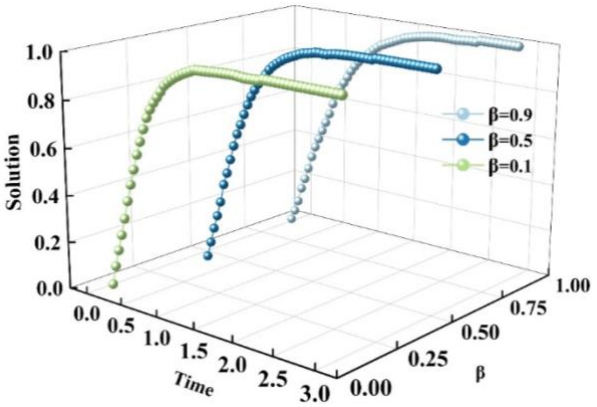
As shown in Fig. (d), when the level of digital platform construction γ gradually improves, the possibility of carrying out the national fitness wisdom transformation and upgrading is getting bigger and bigger and finally converges to 1.



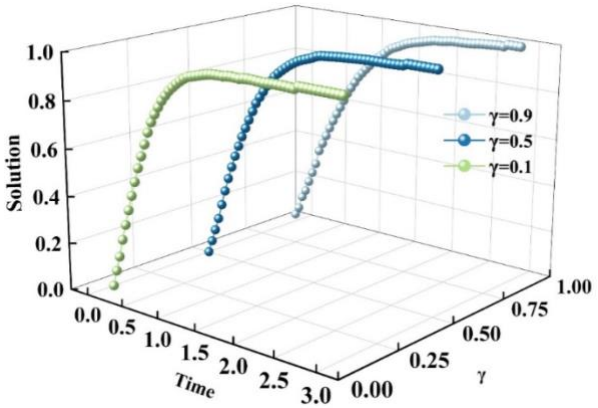
(a) Influence of upgrading cost P on the transformation of national fitness wisdom



(b) Influence of digital ability on the transformation of national fitness wisdom



(c) Influence of data ability on the transformation of national fitness wisdom



(d) Influence of digital platform level on the transformation of national fitness wisdom

Figure 4. Influence of four factors on the transformation of National Fitness Wisdom

4 Conclusion

This study first uses hierarchical analysis to measure the digital technology-enabled national fitness intelligent transformation, and then analyzes the factors affecting its transformation by combining the rooting theory and the evolutionary game model, and draws the following conclusions:

1) Constructing the evaluation index system of national fitness intelligent transformation and analyzing the evaluation results of national fitness intelligent transformation in City Z, it can be seen that the scores of the first-level indexes are in the following order: transformation effectiveness (0.92) > basic guarantee (0.89) > organization system (0.88) > safety guarantee (0.85) > scene application (0.70). Among the secondary indicators, the highest scores are infrastructure guarantee and government satisfaction, both with a dimensionless result of 1.00. The lowest scores are for public services, both with a dimensionless result of 0.77. City Z's intelligent transformation of national fitness has a total score of 95.96, which has a more significant impact.

2) According to the Zagan theory to construct the national fitness wisdom transformation influencing factors model, when the value of transformation and upgrading cost P gradually

increases, the probability of the national fitness wisdom transformation and upgrading will become smaller and smaller. As the ability to digitize service modes and collect and analyze data gradually increases, the convergence speed of national fitness wisdom transformation and upgrading is getting faster and faster. As the level of digital platform construction gradually increases, the probability of carrying out the national fitness wisdom transformation and upgrading is getting bigger and bigger. Therefore, when local governments and communities help the national fitness smart transformation, they should consider the cost of transformation and upgrading, the ability to digitize service methods, the ability to collect and analyze data, and the level of construction of digital platforms in order to carry out an efficient transformation.

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