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# BIG DATA SURVEY ON EMPLOYEE EXERCISE IN NEW HIGH-TECH PHOTOVOLTAIC ENTERPRISES: HIGHLIGHTS ON START-UP PHOTOVOLTAIC COMPANIES

Zewen WANG

*Capital University of Physical Education and Sports, Beijing Province, 100191, China;*
*E-mail: sbjuu5635@163.com*

**ABSTRACT**

Numerous studies show that scientific and reasonable physical exercise can promote human health. Reasonable exercise prescriptions based on an individual's physical condition is important in improving one's health. On this basis and through the investigation on the big data of emerging high-tech photovoltaic enterprises, the development and design of a human health model and science in sports are developed based on ant colony optimization algorithm. Finally, the requirement analysis, design, specific application, and model algorithm testing of the physical fitness exercise prescription model can provide a scientific strategy for human health and scientific movement.

**Keywords:** high-tech, photovoltaic, physical exercise, fitness function, fitness value

## 1. INTRODUCTION

The photovoltaic (PV) industry in emerging strategic industries has recently experienced an explosive growth trend, which has led to economic growth in related regions. At present, the capacity of China's PV industry has reached 35 GW, which exceeds the total installed capacity of the world. Overcapacity has become a major problem that cannot be ignored in China's PV industry [1]. China's PV industry has sold more than 90 % of its products to developed countries, such as Europe and the United States, because their governments provide many subsidies for solar power enterprises. However, the government's subsidy for solar power companies has been greatly reduced due to the European debt crisis and other issues, which has seriously affected the sales of Chinese PV products abroad [2]. For example, Germany reduced the on-grid tariff of solar energy by 15 %, and Spain, France, the Czech Republic, and other European countries are also reducing their support for the solar power industry. In 2012, China's PV products suffered another round of anti-dumping investigation abroad. Under the pressure of a series of problems, such as the reduction of foreign demand, the large margin of profit, the collapse of enterprises, and the intensification of international trade disputes, China's PV industry has encountered an unprecedented crisis [3]. Under such enormous pressure of "foreign invasion" China's PV industry must turn its attention to the domestic market to escape the crisis. At present, although the output of PV modules in China has reached 80 % of the world's output, its installed capacity of PV accounts for only 8 % of the world's total. At the end of 2011, the total installed capacity of PV was less than 4 GW. For emerging high-tech PV companies, talent is critical. The cultivation of talents in emerging high-tech PV companies not only requires high comprehensive skills but also a healthy body [4]. On this basis, the investigation on the big data of the employees of high-tech PV start-ups is launched.

## 2. STATE OF THE ART

Since 1991, China has successively established 53 state-level high-tech industrial development

zones (hereinafter referred to as high-tech zones). By the end of 2000, the number of high-tech enterprises in the country was 20,796, employing 2.5 million people and increasing by 38 % annually [5]. As an important part of the national "Torch Program" for developing high and new technology industry, the National Hi-tech Zone has become the most dynamic economic growth point in the country and an important force to pull the regional economy. Emerging industries are mostly transformed from high-tech industries. The destructive effect of technological innovation on the traditional market has led to emerging strategic companies to face conflicts with traditional industries, the market, and the original system in the process of gradual growth [6]. Under the background of the increasing energy crisis and environmental problems, the PV industry, as an important part of the new energy industry, has been highly valued by all countries in the world, and it is one of the relatively fully developed industries in the emerging strategic industrial system. Under the existing market mechanism and industrial environment in China, the experience and lessons of the PV industry in the process of development are of considerable importance for the PV industry itself, as well as other emerging strategic industries [7].

## 3. METHODOLOGY

### 3.1. Model of the Physical Training Prescription for New and High-Tech PV Enterprises

The technical principle of "two-dimensional dynamic exercise intervention program" is based on the theory of sports health promotion of the American Sports Medicine Association [8]. According to the index of the current physical state of the body (e.g., body weight and body composition), body strength, muscle strength and endurance, blood pressure, blood sugar, and energy consumption, this personal index dimension is analyzed in combination with external environmental factor indicators (e.g., temperature, humidity, season, geographic location, and project suitability). Through the learning mode, the intelligent decision fits an individual's exercise program. The route is as follows. Samples are tested, and the error of each sample is calculated to determine the fitness value:

$$E = \frac{1}{2}\sum_{k=1}^{n}\sum_{j=1}^{p}(y_j^k - o_j^k), \quad (1)$$

where $n$ is the number of training samples, $p$ is the number of output nodes, and $y_j^k - o_j^k$ is the error of the $k^{th}$ sample relative to the $j^{th}$ output unit. The fitness function is set to fitness equal to $l/E$. The selection operation uses a sorting method. According to the fitness value of each individual sample sorted from smallest to largest, the individual with the smallest fitness value corresponds to a serial number of *1*, and the individual with the largest fitness value corresponds to a serial number of $M$. After sorting, the sample with the serial number $i$ corresponds to a relative fitness value $fitness_i$, as shown as follows:

$$fitness_i = \max - [(\max - \min)(i-1)(M-1)], \quad (2)$$

where max is [1.3, 1.7] and min is [0.2, 0.6]. Subsequently, on the basis of the relative fitness value of each sample, the selection probability of the sample is calculated according to the fitness proportion selection (stake) method, as shown as follows:

$$P = fitness_i / \sum_{i=1}^{M} fitness_i. \quad (3)$$

Cross operation adopts mathematical crossover, followed by probability $P_c$ to cross select two samples, XI and X2 and obtain two new individuals, X1 and X2, where I is the crossing point adopted, 1 or less than $i$ $n$; $n$ is the chromosome length; and $a$ is the predetermined real number, $0 < a < l$.

$$X_1 = aX_{1i} + (1-a)X_{2i}. \quad (4)$$

$$X_2 = (1-a)X_{1i} + aX_{2i}. \quad (5)$$

The variant operation uses the non-uniform variation to set the variant parent $X = wlw2w3...$ $wk...$ $wl$. Using the non-uniform variation, the variation point wk is randomly determined by the probability $Pm$. The range of the value of $wk$ is $\left[U_{min}^k, U_{max}^k\right]$, and the new gene value $w_k$ is determined as follows:

$$w_k = \begin{cases} w_k + \Delta(t, U_{max}^k - w_k) random(0,1) = 0 \\ w_k + \Delta(t, w_k - U_{min}^k) random(0,1) = 1 \end{cases}. \quad (6)$$

Random (0, 1) represents the probability of equality from 0 to 1, and *t* denotes evolutionary algebra. In delta (T, Y) (Y represents $U_{max}^k - w_k$ and $w_k - U_{min}^k$ represents [0, y], which range conforms to the non-uniform distribution of random numbers with the increase of evolutionary algebra T), the probability of delta (T, Y) approaching 0 also increases. T is the largest evolution algebra; *r* whose range is [0, 1] meets a random number of uniform probability distribution; and *b* is the coefficient of determining non-uniformity [2, 7]. Therefore, the non-uniform mutation allows the operator to search uniformly in the solution space at the beginning (*t* is less), whereas it has partial search property in the later stage (*t* is close to T). The two-dimensional dynamic exercise intervention program should include sport types, exercise intensity, exercise time, exercise frequency, exercise progress, and precautions.

***Sports Type***

Common types of exercise may generally include endurance (aerobic), strength, stretching (flexible), balance, agility, and speed exercises.

Exercise intensity. Exercise intensity is the core of exercise prescription and the most difficult part in designing exercise prescription. The corresponding exercise intensity can be determined on the basis of the result of exercise load test.

***Duration***

The interval training method, continuous training method, and intermittent continuous combination training method can be used in the exercise prescription to enhance cardiopulmonary endurance. The effective time of the exercise, that is, the time during which the exercise is performed, must be maintained.

***Number of repetitions, number of completed sets, and interval time***

In the exercise prescription for enhancing cardiopulmonary endurance, when the interval training method is used, specifying the running distance, the completion time of each running distance, the interval time, the number of completions, and so, the total number of completions becomes possible.

***Exercise frequency***

Exercise frequency refers to the number of exercises per week. One only needs to exercise once a day, 3–4 times a week, or once every other day.

***Precautions***

Attention must be paid to the safety of sports in implementing exercise prescriptions. The safety of venues, facilities, clothing, and the environment must be ensured. The safety instructions in the exercise prescription should also be followed during the exercise. For example, exercise intensity should not exceed the prescribed prescription, proper exercise, and exercise time.

### 3.2. Ant Colony Optimization Algorithm

First, the weights are determined. Each enterprise is abstracted into an antill, which must have memory capability. The weights are determined by comparing the data in the relational model G. A taboo list of PGs for each ant is used to record whether the current ant has been allocated. PG tables must be updated constantly and must be emptied before the next start. Second, a match between the employee and the physical exercise program is then observed. For an employee who can perform multiple sports, the relationship model must determine which employee is most suitable for which sports event. This condition is similar to the ants performing a match in the ant colony algorithm and comparing it with the last best match to determine which of the edges with weights has the largest weight. Third, pheromone is selected. Pheromones are the degrees of influence exerted by employees who have exercised on those who have not. The volatilization characteristics of pheromones include the mood, the state, and the working condition of the employee on that day, and the effective use of positive and negative feedback algorithms. The pheromone strategy in the MMAS algorithm is selected to prevent the premature convergence of the algorithm and lengthy computation time. Furthermore, probability selection is applied in the algorithm to satisfy the randomness requirements.

$$P_{ij}^k(t) = \begin{cases} \dfrac{[\tau_{ij}(t)]^\alpha [\eta_{ij}]^\beta}{\sum\limits_{s \in allowed} [\tau_{is}(t)]^\alpha [\eta_{is}]^\beta} & j \in allowed_k \\ 0 \end{cases}, \quad (7)$$

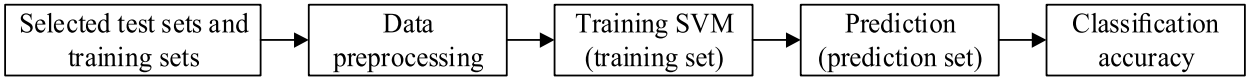


Fig.1. Algorithm flow chart

where $tabu_k (k = 1, 2, 3, \ldots n)$ represents the set of all nodes that ant $k$ is currently walking through, and $allowed_k$ represents the set of ants that has not passed the point.

$$\tau_{ij}(t+n) = (1-\rho)\cdot\tau_{ij}(t) + \Delta\tau_{ij}, \tag{8}$$

$$\Delta\tau_{ij} = \sum_{k=1}^{m} \Delta\tau_{ij}^{k}, \tag{9}$$

where $\rho$ denotes the pheromone volatilization coefficient $i$, (1-$\rho$) denotes the pheromone residual factor, and $\Delta\tau_{ij}$ denotes the pheromone increment on the path in the current cycle and the amount of information that the $k^{th}$ ant remains on the path in the current cycle.

$$\Delta\tau_{ij}^{k} = \begin{cases} \dfrac{Q}{L_k}, & \text{If } K \text{ only ants pass through this cycle } (i,j) \\ 0 & \end{cases}, \tag{10}$$

$$\eta_{ij} = \frac{1}{(100 - d_{ij})}, \tag{11}$$

where $d_{ij}$ is the degree of employee satisfaction with a certain sporting activity. The heuristic factor $\alpha$, expected heuristic factor $\beta$, number of ants $m$, and coefficient of volatility $\rho$ of the algorithm are derived from the eil51 in the TSPLIB simulation experiment and Zhao's research on arranging classes based on the ant colony algorithm. The following values are used in the algorithm: $m = 5$, maximum number of iterations = 40, $\alpha = 1$, $\beta = 5$, $\rho = 0.3$, $\tau_{\max} = 1000$, $\tau_{\min} = 0.01$, and $Q = 20$. For the MMAS pheromone, only one ant performs pheromone updates after each cycle. The value range of each pheromone is limited to $[\tau_{\min}, \tau_{\max}]$. When the pheromone value is $\tau > \tau_{\max}$, $\tau = \tau_{\max}$ is considered; when the pheromone value is $\tau < \tau_{\min}$, $\tau = \tau_{\min}$ is taken. For the maximum matching of bipartite graphs, the graph is a mathematical model that uses dots and lines to characterize discrete objects $d_{ij}$ collections, and objects in some way.

The main steps of program algorithm are presented in Fig.1.

Health fitness management can be divided into five aspects, namely, personal health test, physical fitness assessment, intervention effectiveness assessment, physical fitness intervention, and physical fitness training and guidance.

Healthy fitness, the basic information of managers: the management platform functions as a questionnaire, and managers can use the Internet to fill out questionnaires and determine their basic information. Survey questionnaires can use the software's own questionnaire model, and users can also edit the questionnaires to learn useful information from the managers.

Physical fitness assessment: the evaluation of employees' physical fitness mainly includes items stipulated by the standards for physical fitness testing of the employees. These items include indicators of reaction morphology and indicators of responsiveness. Indicators of responsiveness can be used as the basis for evaluating physical fitness.

Exercise load test evaluation: the incremental load exercise program and the synchronous testing of the relevant physiological and biochemical indicators as the basis for the development of exercise intervention can be utilized based on actual needs. Health-related indicators include muscle strength and muscle endurance, cardiopulmonary function, bone density, and body composition. Through these test items, the purpose of the intervention can be determined from the perspective of healthy physical fitness.

Physical fitness intervention: after formulating corresponding exercise prescriptions, relevant physical fitness interventions are performed according to exercise prescriptions. The supervision function of the software and the monitoring function of the terminal equipment are optimized to perform related exercise interventions effectively and reasonably. In the physical fitness management evaluation, about 4–6 weeks of exercise intervention and timely evaluation confirm the effectiveness of the intervention and the effect of the evaluation and adjust the intervention program to perform well in the subsequent intervention and management.

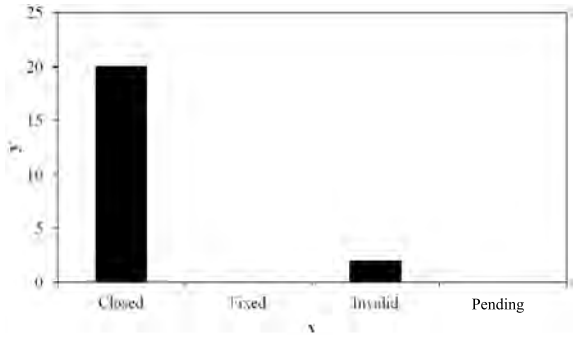


Fig.2. Bug distribution

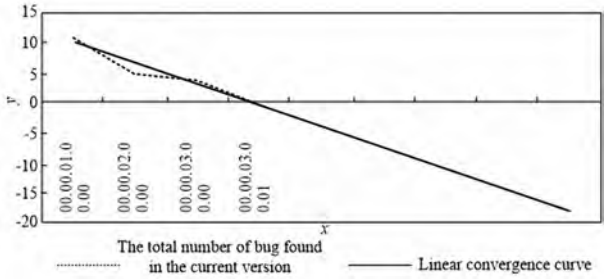


Fig.3. Bug convergence curve with the change of version

Physical fitness training and guidance: most of physical fitness management uses external factors for management and supervision. The managers must be supplemented by teaching and instruction for the internal factors to work and let them think about the importance of the health ideology and then consciously exercise. Education and counselling can take the form of DIY software, books, newspapers, conversations, or using the Internet. Managers should use their own characteristics to conduct healthy physical fitness assessment in the actual work.

## 4. RESULT ANALYSIS AND DISCUSSION

The test cases verify the normal implementation of the entire system function through several major points, such as member registration, selection of test items, and verification of test item functions, personal analysis, print report, and interface. A simple explanation of the use case of "Verification Test Item Function" is shown in Table 1. The testing methods of other function points are the same as the testing methods of this function point. They all consider whether the verification testing program can be selected normally and whether the input data can be saved normally.

Each version of bug distribution (bug with the version of the convergence curve) is shown in Figs. 2,3.

As shown in Fig. 3, the number of problems discovered converges with the version. Among them, the test focus of version 00.00.01.00.00 to 00.00.03.00.01 mainly focuses on functional testing and verifying whether the business process of its management software is correct and whether the test project screening scheme is correct, including personal analysis and report verification. Bug severity distribution is shown in Fig. 4.

As shown in Figs. 4,5 among the 20 valid bugs, none have "4-Critical" level, fatal problems, stable functions, and excessive abnormalities; the 3-Serious and 2-Medium are 20 % and 30 %, respectively. This result is mainly caused by the function settings and the actual implementation of the performance, which do not match the error after the interface switching. Moreover, the level of 1-Low ratio is 50 %, which mainly aids information and prompts information error, Table 2. The ETT test officially began entering the testing phase on May 17, 2017. During the project testing process, four test versions were made, resulting in 20 effective bugs. Through the six aspects of the test in the use case, the software function was realized normally, the operation was stable, the operation and use were in accordance with the common user's operating habits, the friendliness promptness was clear, and the use of the user was well guided.

Weight reduction exercise prescription has the highest priority in this system. From the aspect of the direct relationship between body weight and body weight, weight reduction belongs to the in-

**Table 1. Function Testing**

| Functional testing | | | | |
|---|---|---|---|---|
| Test phase | Test cycle | Working hours (human hours) | Total number of problems | Problem discovery rate (per hour) |
| Functional test stage | 2012.5.17 ~ 2012.5.24 | 63 | 20 | 0.33 |

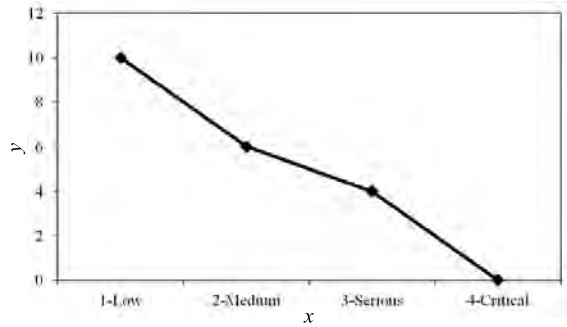


Fig.4. Severity degree distribution of bug

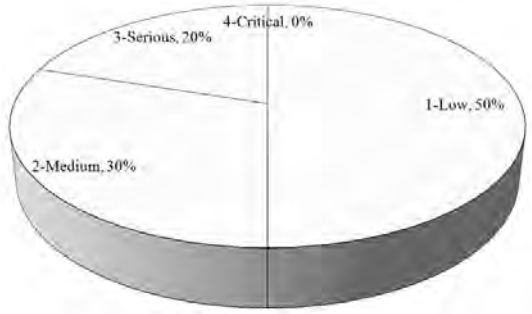


Fig.5. Severity distribution

**Table 2. Severity Degree Distribution of Bug**

| Severity | Number | Percentage, % |
|---|---|---|
| 1-Low | 10 | 50 |
| 2-Medium | 6 | 30 |
| 3-Serious | 4 | 20 |
| 4-Critical | 0 | 0 |
| *Total* | *20* | *100* |

dex of the body shape subsystem. Therefore, the related parameter equations are set in the body shape subsystem. Similarly, a 50-year-old male ID with wg656 as an example (weight exercise prescription) was employed to perform a system dynamics analysis of the effects of exercise prescriptions. The ID with wg656 user-related fitness test information is entered into the model, related parameters are set according to age and gender, and a system dynamics model is established. The user needs to lose weight, and the difference between his actual and ideal weight is 21.99 kg, which is an unscientific goal in the 12-week exercise prescription cycle.

Through the system dynamics simulation of weight-loss exercise prescription, the results of changes in the secondary indicators of physical fitness, and the improvement of body shape, the physiological function changes to a certain extent, which can be understood as the physiological function produced with the change of body shape. Changes in fitness, body shape, and physiological function result in comprehensive changes in physical fitness, that is, changes in body shape affect the comprehensive changes in physical fitness. The weight-loss exercise prescription for body shape change is insensitive to changes in physical fitness. It is manifested as a change in body shape, and the change in physical fitness is small and shows no change (physical fitness is a straight line). Setting a weight-reduction exercise prescription has minimal significance in the development of physical fitness. Therefore, in the development of weight-loss exercise prescription, the desire to achieve good results in physical fitness necessitates performing special quality exercises to obtain good overall physical fitness evaluation results.

## 5. CONCLUSION

The analysis on the big data of the high-tech PV start-ups' employees shows that the individual differences in the quality of the employees' quality inspections, together with the degree and methods of physical exercise, have different results. Therefore, how to cultivate employees' life-long sports awareness based on their individual differences should be a top priority for emerging high-tech PV companies. An exercise prescription software system wherein employees routinely load their own characteristics is designed, that is, an employee physical fitness exercise prescription system. This system, combined with the physical exercise model, plays an active role in the employees' daily exercise and forms good exercise awareness. Endurance exercise has a significant training effect on enhancing the capability of the respiratory system to take up oxygen, the cardiovascular system load and the capability to deliver oxygen, and the capability of the tissue to use oxygen for aerobic metabolism; thus, endurance training and endurance training are designed for endurance training.

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***Zewen WANG,***
Master of education, postgraduate student, graduated from the Capital University of Physical Education and Sports in 2016, Studied in Capital University of Physical Education and Sports. His research interests include athletic performance and health promotion