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# Practical Teaching Reform of Marketing Major for Graduates' Post Competency of Their Early-Career Stage

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**Abstract**—for graduates, the early-career stage means the first two or three years since they are engaged in a job. Their job performance at this stage is closely related their learning and training in university. This paper put forward a practical teaching design oriented the post competency, and then applied this design in marketing major of our university. Firstly, we investigate the competence characters of several kinds of marketing positions, and then filter some competence indexes as the important requirements of the early-career stage. Secondly practical teaching is designed or modified for promotion of these competence indexes of students. Finally, we also compare and evaluate the graduates' performance in their post by interviews with the employee in order to demonstrate the implementation effect of practical teaching reform.

**Index Terms**— post competence, early-career stage, practical teaching reform

## INTRODUCTION

Educating and transporting talents for the society is the primary target of Higher Education. To achieve this goal, the theory and practice teaching system which are the main component of talent training plan of university are constructed and implemented to cultivate the quality and ability of students. The practical teaching is the intermediate link from the theoretical teaching to the professional post, and is also an important means to reduce the gap between theory and practice.

According to the theory of career, the personal career can be distinguished according to the characteristics of different stages. As a formal member of the qualifications, 17-30 years of age is an early important stage to assess each person's career and make people assume their responsibilities and abilities [1]. In china, this stage just contains one person's university stage and his early-career stage. The early career of graduate is usually defined as the first three years of work after leaving university [2]. Therefore, the training in university plays an important role in graduates' post competency in their early-career stage

and even will affect their performances on the later career development. In particular, the practical teaching in university will take a key responsibilities for cultivate the competency characteristics of different position.

Post competency is a specific and sustainable individual quality that is causal relationship with high efficiency or outstanding performance in a specific position [3]. Concerned domestic marketing positions, for example, in 1988 Wenzhao Yu [4] put forward that successful marketing personnel should have the psychological quality including self-control, social adaptability, self-confidence, achievement motivation, marketing skills, creativity and professional interest. Thereafter, the research of marketing position competency is further subdivided. Some scholar built the competency model of professional marketing manager [5] and others study the models of sales staff, customer manager, etc. [6][7]. On the other hand, because the post competency is an inevitable requirement for the enterprise to recruit students, there have been carried out a lot of teaching reform for competence in universities. For example, Li designed four kinds of ability training framework based on marketing professional talent training program [8][9]. And Feifei Shen [10] also advised a corresponding practice teaching mode matching after classifying the marketing personnel training target. Some studies also focused on the reform of training program to meet the demand of competence, and Some paper has provided the practical teaching reform solutions of the international economy and trade major[11] or the human resources management major[12] for competency training. In terms of research trends, it can be conclude that the practice teaching reform is gradually developing from the professional competence quality to the more specific post competency training, however, the existing researches have not paid much attention to the post competency of graduates in their early-career stage, and are also less illustrate how to build the corresponding practice teaching to support to make excellent performance on specific post.

Under this background, this paper will analyze the competency of marketing graduates in their early-career stage and correspondingly describe the practical teaching reform in our university. It is also expected to provide a

reference for the graduate in other majors to strengthen competency training.

### I. MARKETING POST COMPETENCE IN EARLY-CAREER STAGE

Students learning marketing is expected to engage in marketing or management when they are employed by enterprises in the future, or be a senior specialist in teaching or scientific research. Nowadays they have more employment opportunities. The Chinese Market Association survey shows that a graduate in marketing major may get a job such as customer service representative, sales manager, sales manager, marketing manager and administrative assistant. At the beginning of his career, he is ordinary regarded as a reserve for one position. In order to understand the requirements of the enterprise human resources department, we conducted a survey about Marketing reserve personnel competency. After interviewing 57 local employers, we have mastered the present situation of enterprise talent pool and graduates' performance from our university. We analyze the graduates in market major from university in the last three years and get proportion of their post choice in the early stage as shown in Table 1:

TABLE I. POST CHOICE

Post	Work content	Proportion
Customer Service Manager	understand customer needs, develop new customers customer relationship maintenance, coordination of various departments to serve customer.	22%
sales manager	Make sales plan, organize sales team and the distribution of resources, Guidance and control of sales.	41%
Marketing Manager	Market analysis, market supervision, assessment of market demand, support for product development and channel laying, price adjustment decisions, etc.	15%
Planning Manager	Promotion planning, public relations activities planning and other sales planning, responsible for the supervision and coordination of the various departments to carry out the plan.	8%
Others	Human resources, administration and other management work.	14%

According to the work content of the different positions, there is a big difference in the nature of the work so that the competency characteristics of different positions are not the same. After comparative analysis, we have summarized the common characteristics and also sort out the specific requirements of competency for the different positions. The employer's requirement for various types of post competency in the early-career stages of graduates is listed in Table 2:

TABLE II. CHARACTERISTICS OF DIFFERENT POST COMPETENCY

Post	Specific Characteristics	Common Characteristics
Customer Service Manager	Interpersonal Communication, coordination	Self-confidence, flexibility, social accomplishment, continuous learning, achievement motivation, creativity, understanding, market awareness, team awareness, etc.
sales manager	Selling skills, Interpersonal Communication	
Marketing Manager	Market Insight, Analysis, Decision Making	
Planning Manager	Innovation, Planning And Coordination	
Others	Affinity, Organization and Coordination	

According to the satisfaction analysis, the employers are basically satisfied with basic ability and quality of graduates, but also expressed some expectations for the requirement to improve specific post competence of graduates. Among the unsatisfied indexes, the more outstanding indicators include "work attitude", "communication skills", "business ability" and so on. The satisfaction analysis also shows the gap between talent training of university and requirements of post competence. So we conclude the main problems as follows:

At first, the gap between the target of practical teaching and the requirement of post competence should be narrow. Although the ability training is the target of the practical teaching of marketing major in university, but in the actual teaching process, the practical teaching is still attached to the theoretical modules. Therefore, it is pay more attention to how to master and apply the basic theories so that it is difficult to focus on and meet the competency requirements of a specific post. This makes the current practical teaching lack of applicability for specific post competence.

Secondly, the differences in professional practical teaching and on-the-job learning methods lead to lack of self-learning ability of graduates. Influenced by the traditional teaching, the methods of practical teaching mainly include simulation, experiment, practical operation and so on. In the process of practical teaching, a lot of work is carried out by the teacher and the student will be required to passively participate in the training, discuss problems and operate with teacher's guidance. So students' ability of self-learning and cooperative learning has not been fully exploited. But after the students graduated from university, they are required by the employer to master a large number of work flows and business rules by self-learning. The environment difference makes the self-learning very important to graduates in their early-career stage. Therefore, how to improve students' self-learning ability through practical teaching should be seriously thought and planning.

Thirdly, the organization sequence of practical teaching of university is failed to effectively connect with specific post. For instance, practical teaching organization of marketing major of university is sequential composed of

unit teaching, independent design, comprehensive training. The purpose of this sequence is nothing more than to encourage students to complete different practical tasks from easy to difficult by the rule of learning so that when students leave university they can have a wider choice of employment. However, in respect of a specific post, this organization sequence is not suitable for competency requirements because of lack of training for the specific post. In contrast, practical training in higher vocational colleges is more targeted, and the training organization goal is clearer. Thus, it is more difficult that the graduates from university than from higher vocational college show their advantages and potential in their early-career stage.

To sum up, if we want to meet the requirement of the marketing post in the early-career stage, It is necessary to modify the practical teaching system of marketing major and design the practical teaching content for specific positions.

II. PRACTICAL TEACHING REFORM OF MARKETING MAJOR

In order to meet the requirements of post competence, we have reformed the practical teaching system of marketing major in our university with the principle of "top design, pilot promotion". We have revised the teaching goals, contents and methods of practical teaching. The main ideas of the practical teaching reform include the following:

A. Reform Ideas

After a short terms of investigation and discussion, we decide to start with the teaching goals and then systematically revise the teaching content, methods and evaluation. The first step includes the selection of specific positions, analysis of post competency, appropriate classification of characteristics. Secondly, to integrate and improve the existing practical teaching contents, we clarify the connection between the practical teaching and the post competency characteristic training, and construct the evaluation index system of practical teaching. Thirdly, we chose the specific practice teaching as a pilot to implement, and gradually improve and inductive teaching methods. Finally, according to implementation of pilot, we identify more positions to reform step by step. At the same time, we also form a closed loop to adopt the continuous feedback of post training with the aid of external enterprise, so as to ensure the quality of practice teaching reform and improve the effect.

B. Key work of practical teaching reform.

1) Position analysis

In order to meet the requirements of the post competency, the first job is to choose what kind of marketing position as the object. At present, there is no unified marketing post list. We select a large recruitment site as a reference. There are seven major types and more than eighty sub-categories of marketing positions. After carding and analyzing these positions, we found that graduates mainly engaged in sales management, customer service, market and other primary jobs. This is consistent with the results of our local research.

Therefore, we choose 4 targeted post, such as sales management, customer service, market research and planning.

2) Characteristics and evaluation of competency of marketing positions

After selecting the 4 kinds of positions, according to the competency model, competency characteristics of each position is classified and sorted out. Based on the evaluation requirements, we summarize and design the indexes of the post competency and regard these indexes as the main standard for practical teaching evaluation. Considering post promotion of one's different career stage, we also grade the characteristics requirements with different levels of post. For example, the skill characteristics of marketing planning positions indexes as shown in table 3:

TABLE III. COMPETENCY EVALUATION INDEXES (MARKETING PLANNING POSITIONS)

Level	Specific Competence indexes	Basic Competence indexes
3	STP strategy planning Integrated marketing strategy Strategic cooperation	1. Communication 2. Office software 3. Solve problems 4. Self development 5. Self management 6. Interpersonal 7. Information processing 8. Recording 9.Organization understanding 10. Professional ethics
4	Develop new product project and define new product strategy. Achievement management plan, Achievement analysis, Achievement analysis feedback	
5	medium and long term plan, marketing objectives, implementation	

C. The design of practical teaching system for post competency

After the post selection and evaluation, we have set up a marketing test class to carry out the reform of practice teaching. In view of the shortcoming of the content, method and organization of practical teaching, we designed a special training program for the experimental class, and adjust a large number of contents, methods and organizations of practical teaching to adapt to the position competence.

The specific design of practical teaching mainly includes the following:

1) Organization of practical teaching.

A practical teaching plan for the bidirectional organization of "vertical" and "horizontal" is set up. "Vertical" is appropriate to advance the comprehensive training, and insert a competency training after the comprehensive training. The main function of the competency training is to strengthen the students' understanding of the work flow of a certain position, and improve the proficiency of students to deal with the job. At

the same time with cooperation between schools and enterprises, to enhance the teaching organization in the practice of early intervention in the organization, Enterprise supervisors can involve in the practical teaching earlier in order to reinforce the combination of the guidance of Enterprise supervisors and the post operation in the competence training. "Horizontal" is to adjust the module and practical operation with position classification as a reference. In this way, we expect to connect the different practical teaching items with the post, and further clarify the purpose of each item.

## 2) Content and method of practical teaching

In order to adapt to the post competency assessment, we also revise the content and method of the practical teaching. First of all, in order to strengthen the basic ability of students, we increase the corresponding training content and design a large number of general post operation. On the other hand, we also set up such as professional etiquette, ethics and other modules to strengthen the students' professional awareness and sense of responsibility. Secondly, in accordance with competence classification we sort out the practical teaching items and adjust teaching arrangement with the levels of deference competence. In the course of items integration, we used the post task card to carry out the work process for training students. And then, on the basis of the evaluation of the various levels, the post competence of the students are gradually improved. Third, for the implicit position competency characteristics, such as role, self-cognition, motivation, quality and other characteristics, we simultaneously design a number of practical teaching items to try to cultivate the graduates' abilities. For example, on the basic of the post task card, in the team training we ask the students as team members to form a team which consist of different positions. So in the team training process, students will complete a number of self-recognition steps to confirm their team role. This method can also be more effective with the evaluation of the graduates' post competency.

### III. CONCLUSION AND EXTANSIONS

Through nearly two years of practice teaching design and revision, there has been initially formed the practical teaching system oriented the post competency of graduate of marketing major in their early-career stage. Architecture of the system is consist of several practical teaching modules oriented post competency abilities, and also includes the post competency evaluation system which can be used for evaluation of effect of practical teaching in post competency training.

After a survey of the pilot promotion, the problems in the reform and implementation of practical teaching can be summarized as two points:

Firstly, the requirements of post competency is different from the traditional cultivation of skills or abilities. It is necessary to construct competency evaluation system to ensure that each characteristic of competency can be clearly defined and evaluated. In order to reduce the burden on the evaluation of practical teaching item, we built a website to construct a students' self-evaluation of the post competency, and to auto reply the enhance

recommendations by the evaluation results. Combining competency evaluation system composed of self-evaluation and teacher evaluation can fully reflect and predict the students' performance in specific marketing positions, and can show a more clear effect of practical teaching.

Secondly, the post competency training should run through the whole teaching process. The post competent should not only be insert in the practical teaching, but also in the theatrical teaching as far as possible. In addition to the added competency training to the practical teaching items, off campus practice is also necessary, such as vacation social practice, second classroom, graduation practice and so on. The concept and content of post selection and competence should be transmitted to students as early as possible. By this way, students' understanding of the post will be strengthen in depth, and discover their ability, competence gradually by the on-going post training. Therefore, when they graduated from university, they may easier to find a suitable post for their own conditions, and reduce the risk of incompetence in their early-career stage.

Post competence is a form of talent demand. It is very important to the graduates from university that they go through the post selection, adaptation and competent in their early-career stage for their rapid integration into the position environment and the establishment of job self-confidence. By the reform of practical teaching organization, content, method of the pilot, we have basically formed 4 kinds of post competency practical teaching modules and construct the competency evaluation system. With the assist of evaluation come from teachers, groups, employer and graduates, the results show that the current teaching system is generally in line with the marketing post competency requirements in early-career stage. The practical teaching reform can not only provide a reference for the graduates to choose jobs effectively, but also for employers to reduce the cost of hiring the right talent. Next step, in order to enhance the flexibility and precision of post selection for graduates in their early-career stage, we will continue to strengthen the position module segmentation and competency evaluation and expand the scope of the pilot to apply to more majors.

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# Research on Cost-effectiveness Analysis of Equipment Based on DEA Method

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**Abstract**—for the sake of reasonable allocation of life cycle cost and improvement of effectiveness of equipment. Using DEA method to make an evaluation on the equipment cost-effectiveness decision with the characteristic of cost-effectiveness analysis. According to the calculation and analysis, get the effective extent of each programs and work out the improvement measures. The DEA method is especially suitable for and have a great application value on the cost-effectiveness analysis.

**Index Terms**— cost-effectiveness, optimization, DEA

## I. INTRODUCTION

Equipment cost-effectiveness analysis is based on the equipment's Life Cycle Cost (LCC) as input, and the equipment efficiency is output, so as to analyze the different development plan and compare to select the best decision-making process. Analysis the relationship between cost and efficiency, then we can significantly reduce the life cycle cost, and improve the efficiency of equipment. At present, the cost-effectiveness analysis has become an indispensable part of equipment effectiveness analysis [1]. Many scholars both at home and abroad continue to explore the methods of equipment cost-effectiveness analysis. In this paper, the data envelopment analysis (DEA) is used to solve this issue. DEA method is a kind of evaluation method which is widely used between the same samples who has the multiple input and output to identify their "relative advantages and disadvantages. Due to this method based on the actual data as the research object, the conclusion can overcome the impact of subjective factors and have strong objectivity and scientific [2]. Based on the above characteristics and advantages, the DEA model is established to study the equipment cost-efficiency in this paper.

## II. COST-EFFECTIVENESS ANALYSIS

### A. Efficiency analysis

We will use the widely used method which is proposed by the weapon system efficiency Advisory Committee (WSEIAC) to measure the equipment efficiency [3]. This method uses the availability, dependability and the

capability of equipment as measuring standard, can be expressed as

$$E = A \times D \times C$$

E—the efficiency of equipment;

A—the availability of equipment, that is the vector matrix of the probability when the equipment in the different states at the beginning of the task;

D—the dependability of equipment, that is conditional probability matrix of a time interval;

C—the capability of equipment, that is the probability matrix of the equipment to complete the task under the given condition.

Equipment efficiency calculation should be combined with the performance indicators of different equipment, the final results will be used as the output of the DEA model.

### B. Cost analysis

The Life Cycle Cost is sum of the direct or indirect cost of equipment throughout the whole process of demonstration, development, production, use, maintenance and protection phases [4]. The structure dividing of the equipment LCC is based on the GJB1364-92 "equipment cost - effectiveness analysis". As shown in Figure 1:

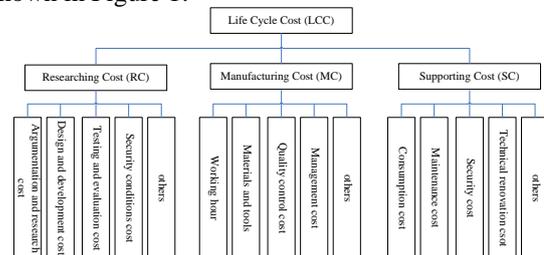


Figure 1. The composition of the Life Cycle Cost

There are mainly three kinds estimation methods of equipment cycle life, which are parameter analysis, analogy method and engineering method [5]. Since the cost of equipment and the retirement costs in the proportion of LCC is small and negligible, the research costs accounted for about 10% while the cost of use is about 30% of the total cost [6]. The maintainance and support costs accounted for the largest proportion of

about 60% and is growing at the rate of 3% per year [7]. Through the calculation of the components of the specific equipment LCC, the result will be the input of the DEA model.

C. Cost-effectiveness tradeoff analysis

Equipment cost-effectiveness analysis is not just study the cost and efficiency respectively, but the process of system analysis. Cost-effectiveness tradeoff analysis is to study the relationship between them and scientific decision-making, and ultimately to ensure the effectiveness of equipment based on the reduction of equipment life cycle costs as much as possible. Through cost-effectiveness analysis, it can not only avoid the design of a single design, but also avoid to neglect the cost or effectiveness of equipment. The analysis should be based on the following:

- (1) More than two solutions must be provided.
- (2) Must have a clear objective requirements.
- (3) There must be a reasonable performance model and cost model.
- (4) The study of the data must be credible.

III. ESTABLISHMENT OF EQUIPMENT COST-EFFECTIVENESS DEA MODEL

The equipment development scheme as decision making units (DMU). The LCC and its compositions as input, the effectiveness and the cost-effectiveness as output to establish the C2R model. Assuming there are n programs  $DMU_j (j=1,2,\dots,n)$ , and the number of input (cost) and output (performance) of each plan is  $m$  and  $s$  respectively. As shown in Figure 2:

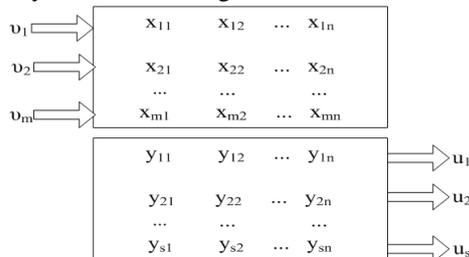


Figure 2. Input and output model of DMU

The  $x_{ij}$  is the value of input  $i$  for  $DMU_j, x_{ij} \geq 0; y_{kj}$  is the value of output  $r$  for  $DMU_j, y_{kj} \geq 0; u_i$  and  $u_i$  is the weight of the input  $i$  and output  $r$  respectively. So the input and output vectors are  $x_j = (x_{1j}, x_{2j}, \dots, x_{mj})^T, y_j = (y_{1j}, y_{2j}, \dots, y_{sj})^T, j = 1, 2, \dots, n$ . The input and output weight vectors are  $v = (v_1, v_2, \dots, v_m)^T, u = (u_1, u_2, \dots, u_s)^T$ .

Define weight coefficient  $\mu$  and  $v$ , the out-to-input ratio is the efficiency evaluation index of  $DMU_j$ . The C2R fractional programming model is constructed under the condition that the index of evaluating efficiency is not more than 1. In order to calculate easily, A.Charnes and W.W.Cooper introduced the non Archimedes infinitesimal

variable  $\varepsilon > 0$ . After a series of changes, finally form the dual linear programming C2R model with non Archimedes infinitesimal:

$$\begin{cases} \max [\theta - \varepsilon (\bar{e}^T s^- + \bar{e}^T s^+)] \\ s.t. \sum_{j=1}^n \lambda_j x_j + s^- = \theta x_{j_0} \\ \sum_{j=1}^n \lambda_j y_j - s^+ = y_{j_0} \\ \lambda_j \geq 0, j = 1, 2, \dots, n \\ s^- \geq 0 \\ s^+ \geq 0 \end{cases} \quad (1)$$

The formula (1) is the conventional C2R model for DEA. Different from the conventional C2R model, the  $DMU_{j_0}$  will be excluded when its evaluation of the efficiency is calculated with the super efficiency DEA model. The input and output of  $DMU_{j_0}$  is replaced by the linear combination of the input and output of all other DMU. In this way, the constraint conditions of the evaluation efficiency index of no more than 1 are removed. Therefore, the model for the evaluation of super efficiency is:

$$\begin{cases} \max [\theta - \varepsilon (\bar{e}^T s^- + \bar{e}^T s^+)] \\ s.t. \sum_{j \neq j_0}^n \lambda_j x_j + s^- = \theta x_{j_0} \\ \sum_{j \neq j_0}^n \lambda_j y_j - s^+ = y_{j_0} \\ \lambda_j \geq 0, j = 1, 2, \dots, n \\ s^- \geq 0 \\ s^+ \geq 0 \end{cases} \quad (2)$$

Set  $\varepsilon$  as the non-Archimedes infinitesimal variable, and the optimal solution is  $\lambda^0, s^{-0}, s^{+0}, \theta^0$  there are:

(1) If  $\theta^0 < 1$ , then  $DMU_{j_0}$  is not effective for DEA, which means that these scheme does not meet the best technical efficiency nor the scale of income unchanged.

(2) If  $\theta^0 \geq 1, \bar{e}^T s^{-0} + \bar{e}^T s^{+0} > 0$ , then  $DMU_{j_0}$  is weakly-effective for DEA, which means these scheme not meet the best technical efficiency and the scale of income unchanged at the same time. If  $s_i^{-0} > 0$ , input indicators  $i$  are idle and the corresponding cost is beyond the best value. If  $s_k^{+0} > 0$ , then the output index  $k$  is insufficient and the corresponding performance index did not reach the best value;

(3) If  $\theta^0 \geq 1, \bar{e}^T s^{-0} + \bar{e}^T s^{+0} = 0$ , then  $DMU_{j_0}$  is effective for DEA, which means that these scheme is the preferred plan and meets the best technical efficiency nor the scale of income unchanged at the same time.

IV. CASE ANALYSIS

A. Model building and solving

Table 1 is the cost and effectiveness data for the 6 options of a certain type of equipment. Establish the DEA model to compare the effectiveness of each program, then find out the best program and develop the corresponding improvement measures.

TABLE I.  
THE COST-EFFECTIVENESS DATA OF THE EQUIPMENT

Programme	Input index (Unit billion)				Output index	
	RM	MC	SC	LCC	E	E/LCC
1	1.5	3.5	5.0	10.0	0.90	0.0900
2	1.2	2.8	7.0	11.0	0.80	0.0727
3	1.8	3.0	6.5	11.3	0.95	0.0841
4	0.8	3.0	6.5	10.3	0.75	0.0728
5	1.0	3.2	6.6	10.8	0.85	0.0787

According to the formula (2), establish the following C2R model, Take  $\epsilon$  for 10<sup>-6</sup>:

$$\begin{cases}
 \min [\theta - 0.000001(S_1^- + S_2^- + S_3^- + S_4^- + S_1^+ + S_2^+)] \\
 s.t. \quad 1.2\lambda_2 + 1.8\lambda_3 + 0.8\lambda_4 + \lambda_5 + S_1^- = \theta \\
 \quad \quad 3.5\lambda_1 + 3\lambda_2 + 3\lambda_3 + 3.2\lambda_4 + S_2^- = \theta \\
 \quad \quad 5\lambda_1 + 7\lambda_2 + 6.5\lambda_3 + 6.6\lambda_4 + S_3^- = \theta \\
 \quad \quad 10\lambda_1 + 11\lambda_2 + 11.3\lambda_3 + 10.8\lambda_4 + S_4^- = \theta \\
 \quad \quad 8\lambda_2 + 0.95\lambda_3 + 0.75\lambda_4 + 0.85\lambda_5 - S_1^+ = 1 \\
 \quad \quad 0.9\lambda_1 + 0.0841\lambda_3 + 0.0728\lambda_4 + 0.0787\lambda_5 - S_2^+ = 1 \\
 \quad \quad \lambda_1, \lambda_2, \lambda_3, \lambda_4, \lambda_5 \geq 0 \\
 \quad \quad S_1^-, S_2^-, S_3^-, S_4^-, S_1^+, S_2^+ \geq 0
 \end{cases} \quad (3)$$

Using MATLAB R2010b to process the data, the operation results are shown in Table 2:

**B. Result analysis**

**(1) Efficiency evaluation index analysis**

According to the calculation results, the efficiency evaluation index of each scheme is obtained. As shown in Figure 3:

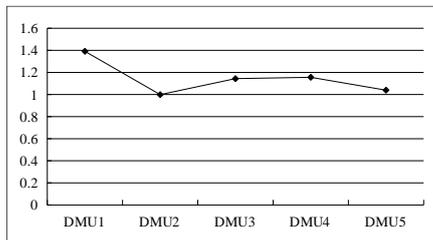


Figure 3. Comparison of cost effectiveness evaluation index of the equipment

In the five scheme, the efficiency evaluation index of schemes are all greater than 1 except DMU2. All programs range from big to small sort of according to their evaluation efficiency index is : DMU1 > DMU4 > DMU3 > DMU5 > DMU2. That is, the effectiveness of the program has a large to the next sort, the comprehensive efficiency of the first program is the highest, and the first program is the optimal scheme followed by the third and

fourth program. Because the slack variables of each scheme are all not zero, all the schemes are weakly-effective which mean that all programs need to be further adjusted. And the specific adjustment programs need to be further analyzed according to the slack variable.

**(2) Slack variables and optimal decision analysis**

Each program to achieve DEA effective, it is need to control the cost in a certain range of targets to make each program to be DEA effective. The specific adjustment measures can be obtained by calculating and analyzing the value of the slack variable  $s^{*+}$  and  $s^{*-}$ . The adjustment amount of input is calculated based on the "projection theory" of DEA [8], and the calculation formula is as follows:

$$x'_{ij_0} = \theta_0 x_{ij_0} - s^-_{ij_0} \quad (4)$$

In this paper, the input parameters of the scheme two are calculated as an example, and the adjustment scheme of the remainder program is calculated in a same way.

$$\begin{cases}
 \bar{x}_1 = \theta \cdot x_1 - s^- = 1.5 \times 0.999 - 0.1605 = 1.3380 \\
 \bar{x}_2 = \theta \cdot x_2 - s^- = 3.5 \times 0.999 - 1.6587 = 1.8378 \\
 \bar{x}_3 = \theta \cdot x_3 - s^- = 5.0 \times 0.999 - 0.0000 = 4.9950 \\
 \bar{x}_4 = \theta \cdot x_4 - s^- = 10.0 \times 0.999 - 1.8193 = 8.1707
 \end{cases} \quad (5)$$

If adjust the second program to be DEA effective, we should control the equipment development cost in 133.8 million, the manufacture cost in 183.78 million, the use of security cost in 4.9950 million, the whole Life Cycle Cost in 817.07 million. By the analysis of the relaxation variables, the adjustment direction and the specific target of the program are given.

**V. CONCLUSION**

The cost-effectiveness analysis is an effective method to evaluate the equipment development plan. The C2R model of SE-DEA gives the efficiency evaluation index of each scheme, compares the effectiveness of each scheme, and offer a macro reference for cost - effectiveness scheme decision. At the same it can provide specific adjustment measures for the cost adjustment according to the value of the relaxation variable. DEA model can be used in the evaluation of equipment cost-efficiency from the micro and macro perspectives, and it has a wide range of application value

TABLE II.  
EVALUATION RESULTS OF EQUIPMENT COST-EFFECTIVENESS

DMU	s <sup>*-</sup>				s <sup>*+</sup>		θ*	Validity
	s1-	s2-	s3-	s4-	s1+	s2+		
DMU1	0.1605	1.6587	0.0000	1.8193	0.1166	0.0000	1.3912	Weekly-effective
DMU2	0.0000	0.0000	1.9053	0.9053	0.0000	0.0000	0.9990	Non-effective
DMU3	0.5883	0.0000	0.0000	0.5883	0.0000	0.0047	1.1439	Weekly-effective
DMU4	0.0000	0.5088	1.4107	1.9194	0.0363	0.0000	1.1563	Weekly-effective
DMU5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0035	1.0392	Weekly-effective

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# Legal Protection for Personal Information Privacy

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**Abstract**—while the privacy concerns raised by advances in information technologies are widely recognized, recent developments have led to a convergence of these technologies in many situations, presenting new challenges to the right to privacy. This paper examines the information technologies and its potential impact on individual privacy interests. Compared with U.S. and EU legislation, the protections in China are backward. The paper first discusses the right to privacy, personal information and information privacy separately, noting ways that new technologies create privacy concerns. The paper then examines the legislation in U.S., E.U. Finally, the paper examines existing protections for privacy in China, considers why they are insufficient, and proposes measures to enhance the legal protection of privacy interests to address these new technologies.

**Index Terms**— personal information, right to privacy, information privacy, legal protection

## I. INTRODUCE

With the technological advancement, personal information is readily available because of the widespread usage of the Internet and of cloud computing, the availability of inexpensive computer storage, and increased disclosures of personal information by Internet users in participatory Web 2.0 technologies. For example, Web 2.0 involves more voices than previous Internet technologies. With more voices online, there is a wider scope for privacy invasion. With more recording technologies readily at hand—such as cell phone cameras and text messaging services like Twitter—there is a wider scope for incidental gathering of details of people’s private lives that can be uploaded and disseminated globally at the push of a button. [1]

The advent of computers required the adoption of specific means to safeguard personal information. One of the most discussed and worried-about aspects of today’s information age is the subject of privacy. There is a new social relationship, human and computers, in the information age.

## II. PERSONAL INFORMATION AND PRIVACY

### A. Personal Information

Information about individual can be divided into three categories—personal information, sensitive information, and personally identifiable information. [2]

Personal information can be regarded as the set of all data that is associated with a specific individual, e.g., date of birth, gender, address, name of first pet, favorite chocolate, high school of graduation, geographical location at 3:14 p.m. on March 30, 2005, and on and on and on.

- Personal information is the set of all information that is associated with a specific person X. Personal information is thus defined in a technical or objective sense.
- Sensitive information is the set of personal information that some party believes should be kept private. If the party is the person associated with that information (call that person X), the set is defined by personal preferences of X, and X’s definition of private (which may be highly context dependent and linked to particular cultural standards regarding the revelation or withholding of information). [3]
- Personally identifiable information (PII) refers to any information that identifies or can be used to identify, contact, or locate the person to whom such information pertains. This includes information that is used in a way that is personally identifiable, including linking it with identifiable information from other sources, or from which other personally identifiable information can easily be derived, including, but not limited to, name, address, phone number, fax number, e-mail address, financial profiles, Social Security number, and credit card information.

### B. Privacy

As we all know today, right to privacy is one of the most important civil rights. The story of the “right to privacy” starts at the end of the eighteenth century. In the 1890 Warren and Brandeis published in the Harvard Law Review an essay titled “The Right to Privacy” defining this new right as “the right to be let alone” [4]. The article was written in response to invasions of personal privacy caused by the technological innovations of mass printing (newspapers) and the portable camera (photographs). With the late 20th century technological innovations of the Internet and the World Wide Web, the collection, use, and dissemination of electronic personal information is potentially much more invasive. [5] As noted above, the right to privacy has long been characterized as the “the right to be let alone.” And yet, today the more practical view may be that “[i]n the digital era, privacy is no longer about being ‘let alone.’ Privacy is about knowing what data is being collected and what is

happening to it, having choices about how it is collected and used, and being confident that it is secure.” [6]

### III. INFORMATIO PRIVACY

#### A. *What is information privacy?*

Technological advances are changing the face of our society dramatically. New technology affects individuals countless ways, including the manner in which they interact with each other, with businesses, and with the government. While technology makes it possible to accomplish many tasks more efficiently, and even to accomplish tasks previously not possible, these accomplishments do not come without costs. Even though they provide solutions to current problems, many technological developments often create new, sometimes unforeseen, problems. One area in which new technology currently is creating such problems is the right to privacy.

A more recent concern regarding privacy rights is information privacy. Information privacy is a component of the fundamental right to privacy. Information privacy involves an individual's personal information and his ability to control that information.<sup>6</sup> Personal information includes data assigned to an individual, such as a social security number, address, or telephone number. Other personal information is generated on a day-to-day basis, such as records of bank transactions, credit card purchases, phone calls, and medical treatments. The “assigned” personal information may be used primarily to identify a subject; the “generated” information may be used to track the subject's activities and habits. This information then can be used, unbeknownst to the subject, by government, businesses, and individuals for any number of purposes.” As society becomes more dependent on computer databases and electronic record-keeping, an individual's ability to control that has access to his personal information becomes more tenuous. [7] This inability to control the use of personal viewed no differently than other commodities in the market gives rise to the issue of information privacy.

#### B. *Information Technology and Information Privacy Concerns*

Technological advancements, coupled with changes in other areas, combine to make the privacy challenge particularly vexing. Technological change is, of course, not new. The printing press has been described as a precursor to the World Wide Web; e-mail and cell phone text messaging have revolutionized interpersonal and group correspondence. Affordability and advances in sensor technologies have broadened the volume and scope of information that can be practically acquired. The privacy debate itself has part of its roots in the technological changes involving the press and technology for photography Warren and Brandeis, in their landmark 1890 Harvard Law Review

paper, were responding to, as they put it, “recent inventions and business methods.” [8]

With the technological advancement, the growing use of personal information in society by both the government and private actors threatens to diminish further the right to privacy. As technological advances increase the amount of daily activities that generate personal information, an individual's ability to control his personal information decreases. This information reveals much about one's habits and routine, and a lack of control over one's “data image” diminishes one's privacy. In the other hand, a person whose privacy has been breached is likely to be concerned about the negative consequences that might flow from the breach, and those kinds of psychological concerns constitute a type of actual though intangible harm entirely apart from the other kinds of tangible harm that the law typically recognizes. Therefore, the right to information privacy in the information age needs more legal protection.

### IV. INFORMATION PRIVACY PROTECTION IN U.S. AND E.U.

Throughout the world, there are several modes of legislation to protect information privacy. The two typical modes are American self-discipline and the European Union's legislative regulation.

#### A. *U.S. Model*

There is no comprehensive federal privacy statute that protects personal information. Instead, a patchwork of federal laws and regulations govern the collection and disclosure of personal information and has been addressed by Congress on a sector-by-sector basis.

Legislative protections of privacy appear in a variety of statutes aimed at both government and private actors. The Fair Credit Reporting Act of 1970 was one of the first attempts to protect individuals' interest in information privacy from private actors, while the Privacy Act of 1974 was among the earliest statutory protections against governmental misuse of personal information. Congress has enacted a wide variety of other statutes in an effort to protect. information privacy, including the Bank Secrecy Act, the Cable Communications Policy Act, the Computer Matching and Privacy Protection Act, the Driver's Privacy Protection Act, the Electronic Communications Privacy Act, the Electronic Fund Transfer Act, Title III of the Omnibus Crime Control and Safe Streets Act (also known as the Wiretap Act), the Right to Financial Privacy Act,” and the Video Privacy Protection Act.

#### B. *E.U. Model*

The US legal system was the first to elaborate on the right to privacy: it surfaced and developed by means of several cases and finally came to be codified in statutory rules. Meanwhile, in Europe, to respond to these fears, enforceable laws throughout Europe have been formulated. The Swedish Data Act was the first national

privacy act in the world; other countries framed their own national legislation successively by the end of 1980s. Many international initiatives have been adopted to protect privacy and personal data, which yield many agreements binding on many nations. Many international organizations such as The Council of Europe (CoE), the Organization for Economic Cooperation and Development (OECD) and the United Nations (UN) has adopted regulations and policies.

Since 1995, the European Union has enacted its own acts, including [9]:

- Directive 95/46/EC of the European Parliament and the Council of 24 October 1995 on the Protection of individuals with regard to the processing of personal data and on the free movement of such data;
- Directive 97/66/EC of the European Parliament and of the Council of 15 December 1997 concerning the processing of personal data and the protection of privacy in the telecommunications sector;
- Directive 2002/58/EC of the European Parliament and the Council of 12 July 2002 concerning the processing of personal data and the protection of privacy in the electronic communications sector (Directive on privacy and electronic communications), abrogating directive of 1997.

### C. Comparing with the Two Models

The United States and the European Union select different privacy protection mode, which relates not only with the legal developing path and history of protection for right to privacy, also with the social and economic, political tradition.

1) The main differences between the US model and the EU model are as follows:

a) *Supervisory measures*: The EU model may also be called the “unitary” model, in which a special organization, which has an independent investigative power, is established. The US model may also be called a “decentralization” model, in which the supervising organizations are scattered in various relevant bodies. For example, medical information and financial information are supervised by relevant bodies.

b) *Supervisory model and manner of personal data protection by the commercial organization and the public organization*: In order to balance the protection and the flow of data, the emphasis of the US model and the EU model are placed particularly in different fields. More emphasis is placed on data protection in the EU, but in America the emphasis is on self-discipline in the commercial organization and on regulating public bodies.

2) Advantages and disadvantages

The mode of United States lacks of effective enforcement measures and means of support lacks of coercive power. This pattern which the interests of both sides are consistent can play its role, if the network industry and users of both sides have an interest conflict, its reliability is questionable. Furthermore, the effect of self-regulation is only to the joined websites and enterprises, without any legal binding to those unjoined.

Comparing with the United States, the advantages of European Union’s pattern are authority, mandatory and stability. But the disadvantages also exist. The main problem is, the rapid development of information technology which challenges this centralized legislative mode. Relative to the rapid development of science and technology, the legislation often appears lag; even hinder the development of science and technology.

## V. LEGAL PROPOSAL FOR CHINA

### A. Current Legal Protection

Comparing with the developed countries, whether theory research, legislative protection or the judicial practice on the right to privacy are very backward in China.

#### 1) Introduction of Chinese law

Generally speaking, the Chinese legal system can be characterized as a civil law system. Therefore, statutory law is main source other than case law. There are generally 6 types of laws in the Chinese legal system. In the order of priorities, they rank as: Constitution, National Law, Administrative Regulations, Local Legislative Regulations, Departmental Regulations and Local Governmental Regulations.

The Constitution is the supreme law of the whole legal system. The National People’s Congress is responsible for legislation and for amendment of the Constitution Law as well as other national laws. The State Council is the chief administrative body and has power to enact nation wide Administrative Regulations. It is chaired by the Premier and is composed of the heads of each governmental department and agency. Under the State Council, various ministries are responsible for supervising different sectors. Operating under the State Council are several Commissions that set policies for, and coordinate the related activities of, different administrative organs. In addition, there are several Offices operating under the State Council that deal with matters of ongoing concern. Apart from these, there are also Bureaus and Administrations operating under the State Council but their organizational status is lower than those of the Ministries.

Each of the governmental entities mentioned above makes relevant regulations for matters falling within its jurisdiction. It is common practice for administrative organs to provide more detailed regulations for the application of National Laws. Local government can also enact laws in areas where they have jurisdiction. But such legislation cannot conflict with the Constitutional Law, National Laws, and the law made by the State Council.

2) The Constitution guarantees the protection to the right to privacy

The Constitution of PRC stipulates that the freedom and privacy of correspondence of citizens should be protected. Article 38 of Constitution of PRC states: “The personal dignity of citizens of the People’s Republic of China is inviolable.” Article 39 states that the residences of citizens of PRC are inviolable. Unlawful search of or intrusion into, a citizen’s

residence is prohibited. Constitution Article 40: "Freedom and privacy of correspondence of citizens of the People's Republic of China are protected by law. No organization or individual may, on any ground, infringe citizens' freedom and privacy of correspondence, except in cases where, to meet the needs of State security or of criminal investigation, public security or procuratorial agencies are permitted to censor correspondence in accordance with the procedures prescribed by law.

3) Other laws and administrative regulations and the decisions of the Standing Committee

- Civil Liability law enacted in 2010 firstly stipulated right to privacy is a separate right of personality.
- Law of the People's Republic of China on Resident Identity Cards stipulates that Public security organs and people's police shall keep confidential citizen's personal information gained through making, issuing, examining or seizing resident identity cards. (Article 6(3)) The Law Article 19 states that Police must not disclose personal information obtained through examining identity cards.
- Postal Law guarantees the protection of freedom and privacy of correspondence and safety of the email. Law of the PRC on the Protection of Minors provides the special group with protection against the breaching of privacy. The State Council also formulated the law that no person may disclose information identifying AIDS sufferers.
- The Regulation on Management of the Administration of Internet Electronic Messaging Services issued by Ministry of Information Industry on 8 October 2000, in which Article 12 states that Electronic Messaging Service providers shall maintain the confidentiality of personal information concerning online subscribers and may not disclose the same to third parties without the subscribers' consent.
- The People's Bank of China made the regulation that banks must keep secret individuals' credit information.

As is obviously observed from the existed provisions in Chinese legal framework, the laws and the administrative regulations demonstrated above do cover data protection to a limited degree. Without a comprehensive data protection law, the existing provisions only give static, rather than expected dynamic, protection to personal data in different aspects and in different areas.

## B. *Legal Proposal for China*

### 1) Adoption of the EU and the US Model

It is suggested by most of the jurist experts that China should adopt the model combining the both the EU and the US model. Chinese legislation model on data protection should absorb both of their essences while in accordance to China's basic social and political situation. Judging from China's current legal and social environment, it appears more reasonable and feasible to base a personal data protection regime on EU approaches to data protection – with necessary modifications accommodating for China's specifics in law and administration, and also to allow for Europe's experiences with implementation of its provisions over

the past decades. In particular, Chinese data legislation model would go more towards the EU model.[10]

Since there is no existing legal system to protect personal data, a fully-fledged EU framework will be set as a comprehensive good model. Relatively speaking, this solution has provided the highest level of protection to personal data and received the vast popularity. Seen from economic angle, as the biggest trading partner of the EU, China must pay attention to meet the international norms, especially EU "adequacy" level for the protection of personal data so as not to be restrained by the flaws in the handling of international data flows. The equal guarantee of data protection will benefit the growth of bi-lateral or multi-lateral trade and economic activities.

In addition, China is also a country whose legislation is based on laws and statutes instead of cases and self-regulations. China is under the same regime as European civil law, rather than case law. The legislation, enactment and compliance of the law in China all need discreet and precise statutes and code. Consequently, the EU model constitutes a fairly reasonable model of legal reference regardless of some deficiencies.

Moreover, there is not yet a strong tradition in China of entrusting industry and professional organizations with self-regulatory tasks and the necessary authority to assume responsibility from the government. In the specific case of data processing industries, it appears that industry associations do not yet have the necessary capacity to establish and implement this kind of self or co-regulatory system.

### 2) Personal Information Privacy Law

There is no such thing as a perfect solution to the matter of privacy protection of such complexity. Even if the EU directive is significant, it is far from being an exact model of legislation to follow but sets a common standard for the protection of personal data. Having heavier international pressure on personal information protection, China should take the initiative to reform and establish personal information protection law, rather than wait to be forced to change its current system.

### 3) Executive Mechanism

It is practical to construct a comprehensive government information resources department on the basis of government reform and restructuring. The department needs to take the comprehensive responsibilities of the management of the information and the use of the technologies involved. Under that circumstance, some measures can be adopted to enhance the efficiency of the enforcement. A case in point is that Germany as well as each province has authority with distinct responsibilities. A further feature of the German law is that the organizations in some cases are permitted to appoint some officials to carry out certain function of protecting data. [11] Independent of the organizations they work with, the officials are required to assist to solve the problem, record the organizational work and make public hearings of the

questions. It has been regarded as a quite successful example of the cooperating work with the relevant supervisory authority, which has been followed by some other states like France, Luxembourg, the Netherlands and Sweden.

Likewise, inspired by the above German practice, it is sensible for the corresponding Chinese government agency to invite some interior information protection officers or experts to ensure the agency's compliance with the information protection regulations. The Chinese government information resources may establish a special information committee of interior officers or other related experts to handle the reconsideration of some case thus acting some of the management as well as enforcement. In such a case, the compliance with the law, also the transparency of the agency work will be hugely promoted.

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# Research on Special Situation Management of Hydrazine Leakage

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**Abstract**—In view of hydrazine storeroom high risk characteristic, the present article analyze the character and the regulation of the special situation management on hydrazine leakage .Working out the relationship between the leak amount and the time by modeling and simulating. To the result, put forward the flow of special situation management on hydrazine leakage and the improved method and technology. What is more, this article provide the theoretical foundation and reference for the special situation management and accident prevention of the hydrazine storeroom.

**Index Terms**—hydrazine fuel, storage tank leakage model, managing special situation

## I. INTRODUCTION

Hydrazine fuel is a colorless, transparent liquid. It mainly has N<sub>2</sub>H<sub>4</sub>, CH<sub>3</sub>NHNH<sub>2</sub> and 2NNH<sub>2</sub> three types [1]. Hydrazine is a kind of liquid propellant with excellent properties, and can be decomposed rapidly under the action of the catalyst to provide the required hydraulic power and electric energy supply to the emergency hydraulic pump and emergency generator to obtain. Although the performance of hydrazine is excellent, but at the same time it also has strong oxidizing, corrosive, flammable, volatile and highly toxic properties. Hydrazine fuel is not only a fire hazard, but also a toxic substance. Therefore, there is a great risk and hidden danger in the process of storage and use of hydrazine fuel.

The treatment process of hydrazine fuel leakage has high risk. If we can master the rule of hydrazine fuel leakage, it will help the security personnel to deal with the danger. In this paper, the method of establishing mathematical model is proposed to simulation and analysis of the leakage process and provide some theoretical support for its disposition.

## II. ANALYSIS ON THE INFLUENCE FACTORS OF HYDRAZINE FUEL LEAKAGE

The main reasons for the occurrence of hydrazine fuel leakage accident include personnel operating errors, safety management defects, equipment damage defects, process failure and external damage, security monitoring

system and automatic alarm system failure, etc. The main factors that affect the leakage of hydrazine fuel include hydrazine fuel storage condition, filling degree, leakage position, leakage area, leakage form and flow limit, etc. [2]

## III. SIMULATION OF LEAKAGE ACCIDENT

### A. Analysis model establishment

Hydrazine is a liquid fuel, and transported and stored by vertical cylindrical tanks. When a leak occurs, it is generally leaked through the hole. Therefore, the model of the hole leakage of the storage tank is studied. Because some factors cannot be mastered accurately, it is necessary to simulate under certain assumptions. We set that when fuel leakage occurs the pressure in the tank is basically kept constant, the leakage is in stable condition, and the external force is not acting on the tank body.

The hole in the tank is located below the  $h_L$  of the liquid level in the tank, its area is  $A$ , the surface pressure in the tank is  $P_g$ , ambient pressure is atmospheric pressure  $P_0$ , and the instantaneous leakage flow rate of hydrazine fuel is  $u$ . The model diagram is shown in Figure 1:

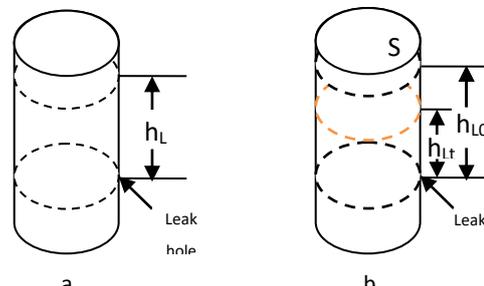


Figure 1. The model of tank leakage

The liquid leakage can be calculated by the Bernoulli equation [3]. When the gap is irregular, it can be replaced by equivalent size [4]. Using empirical formula, it can be known that the mass flux of instantaneous hydrazine fuel leakage is:

$$Q_m = \rho u A = \rho A C_0 \sqrt{2(P_g - P_0) / \rho + 2gh_L} \quad (1)$$

$Q_m$  for the quality of hydrazine fuel leakage rate, the unit is kg/s;  $C_0$  is a hydrazine fuel leakage coefficient, and its value is shown in Table 1.  $A$  for the hole area, the unit is  $m^2$ ;  $\rho$  for the hydrazine fuel density unit, the unit is  $kg/m^3$ .

TABLE I  
THE VALUE OF LIQUID LEAKAGE COEFFICIENT

Reynolds number	Circle (polygon)	Triangle	Rectangle
>100	0.65	0.60	0.55
≤100	0.50	0.45	0.40

With the continuous leakage of hydrazine fuel tanks the liquid height gradually decreased. The rate of leakage and the mass flow rate of hydrazine fuel will be reduced. The initial height of the liquid level in the tank is  $h_{L0}$ , the constant cross-sectional area is  $S$ , and the height of the liquid level at time  $t$  is  $h_{Lt}$ . Its model is shown in Figure 1b.

According to the mass conservation theorem, the instantaneous reduction of hydrazine fuel mass in the storage tank is equal to the instantaneous hydrazine fuel mass from the hole. That is:

$$\rho S dh_L = -\rho A C_0 \sqrt{2(P_g - P_0) / \rho + 2gh_L} dt$$

Finishing available:

$$\frac{1}{\sqrt{(P_g - P_0) / \rho + gh_L}} dh_L = \frac{-\sqrt{2} C_0 A}{S} dt$$

The time for the height ( $h_L$ ) of the liquid surface to drop from  $h_{L0}$  to  $h_{Lt}$ , on both sides at the same time points:

$$\int_{h_{L0}}^{h_{Lt}} \frac{1}{\sqrt{(P_g - P_0) / \rho + gh_L}} dh_L = \int_0^t \frac{-\sqrt{2} C_0 A}{S} dt$$

Solution on the type, finishing to get the time  $t$  of the height of the hole:

$$h_{Lt} = h_{L0} - \frac{C_0 A t}{S} \sqrt{2(P_g - P_0) / \rho + 2gh_{L0}} + \frac{g}{2} \left( \frac{C_0 A t}{S} \right)^2 \quad (2)$$

Put the formula 2 into the formula 1, we will get the mass flow rate of hydrazine fuel at  $t$  moment:

$$Q_m = \rho A C_0 \sqrt{2(P_g - P_0) / \rho + 2gh_{L0}} - \rho g C_0^2 A^2 t / S \quad (3)$$

Then calculate the quality of leaked hydrazine fuel at  $t$  moment by formula (3) :

$$m = \rho S (h_{L0} - h_{Lt}) = \rho C_0 A t \sqrt{2(P_g - P_0) / \rho + 2gh_{L0}} - \frac{1}{2} \rho g C_0^2 A^2 t^2 / S \quad (4)$$

Analysis formula (2) (3) (4), we know that the leakage rate of hydrazine fuel is linearly decreased with time; The decline rate of the liquid level is proportional to the time, the longer the time, the slower the rate of decline; The total amount of leakage and time showed a gradual increase in a lower opening parabolic relationship. When the distance between the liquid level and the hole is 0, the total leakage is the maximum, and the total time is:

$$t = S(\sqrt{2(P_g - P_0) / \rho + 2gh_{L0}} - \sqrt{2(P_g - P_0) / \rho}) / (C_0 g A)$$

B. Case analysis

Take the leakage coefficient as  $C_0 = 0.65$ , the hole area as  $A = 0.000314m^2$ , the initial height level from the hole

as  $h_{L0} = 0.5m$ , the inner surface pressure of tank as  $P_g = P_0$ , the section area of tank as  $S = 0.07065m^2$ , and the hydrazine fuel density as  $\rho = 1030kg/m^3$ . Then get that:

$$Q_m = 0.66 - 0.006t \quad (5)$$

$$h_{Lt} = 0.5 - 0.0094t + 0.0000441t^2 \quad (6)$$

$$m = 0.66t - 0.003t^2 \quad (7)$$

Its corresponding changes are shown in Figure 2, Figure 3 and Figure 4.

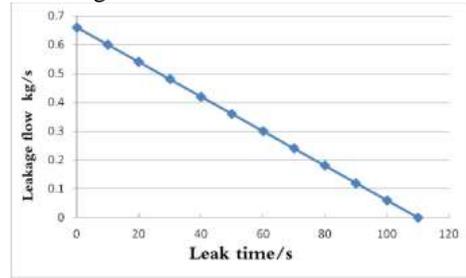


Figure 2. The leakage current

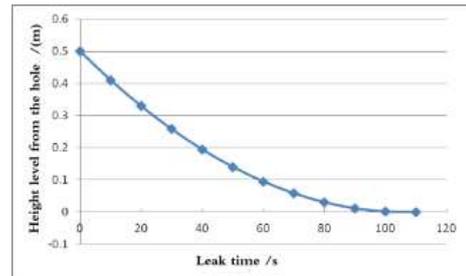


Figure 3. The height from liquid level to the hole

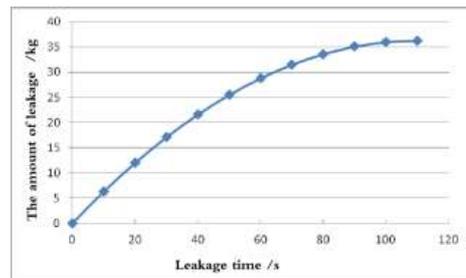


Figure 4. The amount of leakage

It can be clearly seen through the figures that the leakage flow is reduced by an inverse proportion. Began to leak around 30s, the amount of leakage reached 50% of the final leakage, and reached 80% after 60s. Therefore, the faster the faster the leakage emergency disposal, the smaller workload and better results [5].

IV.CONCLUSION

In this paper, the safety characteristics of hydrazine fuel is analyzed. Through the establishment of mathematical model for simulation, the relationship between the leakage flow rate of  $Q_m$ , the height of the liquid level of  $h_L$ , the amount of leakage  $m$  and the time  $t$  were calculated. Finally we analysis and master the rule

of leakage situation and lay the foundation for the next step of rich technical means of dealing with special situations of hydrazine fuel leakage.

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# A Research into Related Legal Control of Cross-border Transfers of Hazardous Waste

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**Abstract**— with the rise of our country’s economic status, environmental issues are also increasingly calling our attention. On the one hand, when our country exports a large number of products to other countries around the world, waste products are stranded in China. In the meantime, “world factory” is “world dump”; on the other hand, some developed countries has been transferring hazardous waste to China, one of their main destinations of waste products. There is a huge gap between developed countries and developing countries in the development economy and technology, whose demands of interests are different. Therefore, both international treaties and domestic laws are faced with legislative defects and ineffective execution. Based on the present situation of related Chinese legal control of cross-border transfers of hazardous waste, some issues are analyzed and the corresponding solution is put forward.

**Index terms** — hazardous waste, cross-border transfers, legal system

## I . INTRODUCTION

In the late 1980s, cross-border transfers of hazardous waste are increasingly serious. Developed countries, considering different standards of environmental regulations, transfer a large number of hazardous waste to developing countries, which thus become “safe harbor of pollution”[1]. In the first International Forum on Sustainable Consumption and Sustainable Production in 2003, Greenpeace International said that in the 1980s the main destination of trading in hazardous waste is African countries. In the mid 1990s, it expanded to Eastern European countries. In the late 1990s the trading range began to be extended to Asian countries. In recent ten years, the trading volumes of hazardous waste have rapidly increased. In 2007 the global trading volumes of hazardous waste increased to 1. 91 billion tons, which have increased by 67% in comparison with 1. 14 billion tons in 2002.

## II . REASONS FOR CROSS-BORDER TRANSFERS OF HAZARDOUS WASTE

First, the growth in the total amount of hazardous waste is a prerequisite for seeking cross-border transfer. To a great extent, the more developed the economy is, the more hazardous waste. The environmental standards of developed countries continue to improve. On the one hand, the category of hazardous waste is wider and wider, which leads directly to the growth in the total amount of hazardous waste; on the other hand, demands for harmless waste have gradually increased, and the treatment costs increase sharply. Therefore, developed countries and enterprises are under heavy pressure of disposal of hazardous waste. As a result, they try to find ways to alleviate environmental and economic pressure regardless of sacrificing in destroying the environment in developing countries.

Second, the profit pattern of the market economy dominates cross-border transfers of hazardous waste through international trade. Although the cross-border transfer of hazardous waste needs more transportation costs, the low cost of disposing of hazardous waste in developing countries is still a major attraction for the enterprises of developed countries. For example, in America the cost of disposing of the risk containing PCBs is up to 3000 dollars a ton, while the cost of exporting to Africa is only 2. 5 dollars a ton.

Third, circumvent the regulation in the name of legality. Typically, the importing countries would agree that the hazardous waste which can be recycled, reused, and has economically valuable.

Actually, though some countries are taking measures in the right direction, a lot of developing countries and countries facing with economic transformation do not have the conditions above.

The collection and disposal of hazardous waste has exceeded the capacity of local governments. Because the international community strengthen the control of

cross-border transfers of hazardous waste, many exporters dump garbage in the name of "recycling".

### III. LEGAL CONTROL OF CROSS-BORDER TRANSFERS OF HAZARDOUS WASTE

The main contents of legal control of cross-border transfers of hazardous waste include: disposing of irregularities judicially, enforcing the law solves the ineffective execution, legislation making up for the blank or the lack and strengthens the public consciousness by educating environmental protection. Because cross-border transfers of hazardous waste and domestic laws are closely related, the waste import and export management system in domestic laws becomes the first legal barrier; the implementation of domestic environmental regulations and standards also determines how much hazardous waste is harmlessly treated. Meanwhile, the cross-border transfers of hazardous waste also affect importers, exporters, transit countries, which becomes the world's environmental issue. Therefore, the principles of international environmental laws, which come into being in the environmental communication, become an important basic international law of solving cross-border transfer of hazardous waste. International environmental law is a branch of international law, which not only has something in common with international law, but also has its particularity. For example, respecting implementation, the "non mandatory internal implementation program" and the "Framework Convention" mode respecting formulation, in other words, which only provide procedural requirements and abstract objective regulations, instead of specific obligations and behaviors. It is because the national compulsory in international environmental law is relatively abstract that all countries need to cooperate more to perform it, namely fulfill its international obligations by using domestic legislation or other means to transform and perform international obligations.

### IV. CHINESE LEGAL CONTROL OF CROSS-BORDER TRANSFERS OF HAZARDOUS WASTE

#### A. *The Conditions of Implementing the Convention in China*

China signed "Basel Convention on March 22, 1990". On September 4 1991 the twenty-first meeting of the Seventh National People's Congress Standing Committee approved it. The state environmental protection administration is the implementation and focal points of the Basel convention. China, one of the earliest signatories to the "Basel Convention", participates actively in all the activities that the Convention has developed, and make a lot of effects in the implementation of the Convention. China not only performs its obligations in strict accordance with the

provisions of the Convention, but also makes domestic laws to curb the illegal trade of hazardous waste. At present, China's regulations on cross-border transfer of hazardous waste, with "solid waste law" at the core of illegal transfer of hazardous waste according to the administrative law, criminal law, civil law, etc. The victims can get compensation or administrative compensation judicially.

First, make regulations and standards to control the import of hazardous waste. From the accession of the Convention on, China formulated "solid waste law" and other relevant laws. Chinese authorities to implement the Convention--the State Environmental Protection Administration has also issued a lot of policies and regulations, and made the corresponding technical specifications.

Second, make national hazardous waste list. On January 4th 1996 the State Environmental Protection Administration, the State Economic and Trade Commission, the Ministry of foreign trade and the Ministry of Public Security jointly issued the "list of national hazardous waste", including categories of wastes, waste to come and send. Afterwards, " list of waste restricting import which can be used as raw materials ", I24 " list of goods banned import", I25 " the catalog banned respecting processing trade " and " the waste directory which can be used as raw materials respecting automatic import license management " are issued. The imports of the waste and hazardous waste on the list are banned, limited or automatically licensed in accordance with the demands of the list. The exports of the waste not included on the list are banned by the country.

Third, strictly control the export of hazardous waste. If the environmentally friendly disposal of the hazardous waste is still difficult, the overseas disposal is strictly controlled in accordance with the "provisions of the Basel conventions". The exporters of waste need to obey the State Environmental Protection Administration. Only after the SEPA gets the consent of the authorities of the importing countries are exports allowed.

Fourth, establish the center of training in managing hazardous waste and technology transfers. In order to promote the implementation of "Basel Convention" in China, on March 6, 1993 the State Environmental Protection Administration set up the center of training in managing hazardous waste and technology transfers in Tsinghua University. On the basis, our country applied to establish the Asia Pacific Regional hazardous waste management training and technology transfer center, after getting the approval of the general assembly of signatories to the Basel Convention. We provide technical training in managing and disposing hazardous waste, technical advisory services and technology transfers for 42 countries in the Asia Pacific region in order for them to improve the ability to solve the hazardous waste pollution.

Fifth, investigate and deal with illegal cross-border transfers of waste. In order to protect our country's

environment and prevent pollution from being transferred, our country cracks down on illegal cross-border transfers of waste. For example, in 1993 Nanjing imported chemical waste from South Korean; in 1995 Nanchang imported waste living plastic from Germany, and so on. The Environmental Protection Departments ordered that the waste should be transported out in accordance with the "provisions of the Basel conventions", which enhanced our national environmental awareness, improved the prestige of the Convention in our country and cracked down on illegal cross-border transfers of waste

#### *B. The Problems in Implementing Legal Control of Legal Cross-Border Transfers of Hazardous Waste*

##### •Lax Regulation of the Environment, Weak Prevention and Slow Response

For nearly twenty years of China being a signatory to the convention, we haven't been able to stop developed countries from dumping waste into China effectively. On the contrary, there is a growing trend. Southeast Express reported that in 1997 England dumped about one hundred twenty thousand tons of waste into China. However, by 2005 England has dumped as much as one thousand and nine hundred thousand tons of waste into China. For only eight years' time, the amount of waste was one hundred and fifty-eight times as much as before; in 2002 SVTC and BAN jointly announced the results of the investigation into Asian electronic waste imports, which show in the USA every year about 50 - 80% of electronic waste is exported to Asia; the main target country is China; 127 besides, "Guijun phenomenon" has drawn widespread attention, etc. To a great degree, these incidents show weak regulation of the environment, weak execution, the lack of consciousness of prevention and slow response in China.

##### • Ignore the Strict Environmental Standards in the Process of Economic Development

China has been modeled as the "world factory" model of economic development since the 1980s, which promoted the rapid development of economy, but it caused some serious problems[2]. The reason was that not only it consumed a lot of resources, but also some pollution-intensive industries especially high pollution-intensive industries transferred the eliminated technology, equipment, production process, hazardous waste to China. In the producing process, these foreign-invested enterprises seriously polluted the environment and greatly destroyed the ecological balance and environmental protection in china. In addition, our country's environmental standards are too low, which was not paid enough attention to at the initial stage of the economic development, thus causing irreparable damage to our environment[3].

##### •The Legal Control System is in Chaos and the Relevant Provisions Don't Fully Conform with the Convention.

At present, our country's legal system of cross-border transfers of hazardous waste is not a well-established system. The relevant provisions of

hazardous waste are mainly dispersed in a variety of laws and regulations, which appears to be fragmentary and not systematic. The "solid waste law" has made some integration, though. Because in China most of the laws and regulations on cross-border waste are promulgated by different legislatures or the authorized legislatures, some of which are still on specific issues of certain periods, they are not logical. So are a lot of waste lists. The reality of the legislation will inevitably lead to the complexity and chaos of hazardous waste control systems. Besides, the "solid waste law" itself has some defects. For example, the specific measures don't match with the basic system; there is a lack of mechanisms for dealing with performance and compliance; the liabilities and compensations are not clear. Most importantly, this law does not fully conform with the Convention. First of all, the definition "solid waste law" still retains the concept of "solid waste", which is not consistent with the provisions of the Convention; secondly, "solid waste law" doesn't ban on the transfer of all sorts of waste, but the waste isn't classified entirely consistent with the Convention.

#### V. IMPROVE THE COUNTERMEASURES OF LEGAL CONTROL OF CROSS-BORDER TRANSFERS OF HAZARDOUS WASTE IN CHINA

##### *A. Further Improve the Existing Management System of Hazardous Waste*

In "Solid waste law" revised in 2004, the provisions of controlling cross-border transfers of hazardous waste from overseas to China border is still relatively rough. It suggested that the law and the existing normative documents of relevant departments should be improved in order to formulate a specific administrative regulation -- "environmental management regulations of the import and export of hazardous waste ", which systematically regulates the management procedures and related responsibilities of the import and export of hazardous waste. Meanwhile, our country should timely adjust the import management list of relevant waste, expand the application of the examination and approval system, and cancel the automatic license of imports. Moreover, each conference of signatories to "Basel Convention" adopted many technical documents including the methods of handling and disposal and the technical specifications of treating certain hazardous waste, which was suggested as important references to establishing the technology standards of hazardous waste storage, treatment and disposal. In addition, China has also been proposed to carry out the full supervision of hazardous waste. The related business entities of disposing of hazardous waste, waste transport, storage, and the final standard of disposal must comply with the corresponding legal norms. Most importantly, these management measures and laws and regulations should be put into practice.

*B. The Establishment of Mechanisms for Preventing Environmental Risks of Hazardous Waste and the Liability and Compensation System of Hazardous Waste*

Considering the reality that our country is a "big country of foreign investment", our country should establish a strict prediction and evaluation of risk system of hazardous waste. In this system the whole process of the production, transport, storage, treatment and disposal of hazardous waste which may cause damage to human health and the environment should be predicted and prevented. The risk assessment of the pollution, harm of hazardous waste, and unexpected problems is necessary. We should take precautionary measures in advance and emergency response so as to reduce the risk of decision-making and uncertainty in the environmental management. Especially the environmental Assessment of foreign-invested enterprises can not be subject to immediate economic benefits. The costs of environmental aspects must be fully taken into account. Meanwhile, considering the amendment and protocol of the Convention have not taken effect yet. In order to effectively manage the cross-border transfers of hazardous waste to China, China should establish the system of liability, compensation and insurance in order to effectively maintain our legal rights when cross-border transfers of hazardous waste cause damage. In addition, in the framework of the protocol of "Basel Convention", our country should strengthen bilateral agreements with other countries so that we can provide the strong protection compliant with the protocol for the victims.

*C. Strengthen the Supervision and Management of Hazardous Waste*

First, we should strengthen the supervision and management of the competent authorities, crack down on the illegal import of hazardous waste, and always keep the pressure up for regulating the import of hazardous waste and other waste[4]. Customs should strengthen the supervision of the single imported trial, risk analysis, on-site inspection and perform all the necessary customs procedures; the environmental protection departments should strengthen the supervision of the acceptance, review, approval for the application for the export of hazardous waste. If necessary, the horizontal linkages between environmental protection departments, industry and commerce, taxation and other departments should be established. They should exchange information, establish a solid liaison and coordination mechanism, and manage together to strictly crack down on the illegal import, processing and production, sale and smuggling of the imported garbage[5]. In addition to strengthening the supervision, the inside jobs and negligent behaviors should be seriously punished. In

practice, in many cases illegal waste trade plan is carried out due to each other's collusion and mutual favoritism of private companies, customs, port staff, and even some government department. Therefore, formulating laws and regulations, and cracking down on these people's illegal acts are also keys to stopping the trade in the illegal waste[6].

## CONCLUSIONS

In order to achieve effective management of transboundary movements of hazardous waste problems, more attention should be paid on the national laws and clear designation of its standards, as well as international agreements. On this basis, the essential way to solve this problem is to strengthen the supervision, and ultimately build a set of scientific, feasible, systematic regulation mode of operation.

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# Research on the Reform of Personnel Training Mode of Business Administration Major Based on the Background of Innovation and Entrepreneurship

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**Abstract**—Based on obtaining knowledge and skills, the innovation entrepreneurship and employment, the reform of personnel training mode in higher institutions is a complex multiple dimension system engineering and important content that involves the construction of innovation country. It conforms to the development of higher education in our country at present, and its core idea is to cultivate college graduates with high innovation and entrepreneurship quality and ability. And the business management major is the key to the operation of the enterprise, personnel training mode reform on its innovation and entrepreneurship oriented, focus on six aspects of training scheme, theoretical system, practical teaching, teaching methods and assessment methods, teaching content, training evaluation, etc., training innovation and entrepreneurship management talents to meet the needs of society development in order to achieve the sustainable development of business management major.

**Index Terms**—innovation and entrepreneurship oriented, business administration major, personnel training mode, content reform

## I. INTRODUCTION

Innovation entrepreneurship education is an important approach to cultivate the innovative entrepreneurial talents, innovative entrepreneurial talent training is the objective requirement of the construction of an innovative country. Because not all college students be fit for the future entrepreneurs and entrepreneur's quality requirements, so you can't just imply defined the innovative entrepreneurial education as training students to start a company, and its location should be to cultivate innovative entrepreneurial talent having autonomy, innovation, risk-taking, forward-looking and competitive ability which is needed by the social and economic development. Through the cultivation of entrepreneurship and innovation ability, will help the students to make better planning and management for their future career, at the same time in the two aspects of the employment and business to provide strong intellectual protection and support.

In recent years, with the contradiction has become increasingly prominent between the cultivation of talents in colleges and universities with unit of choose and employ persons demand , college graduates employment pressure is becoming more and more serious, in order to change this situation, the priority should transform the traditional employment as innovative entrepreneurial university education concept, perfecting the training plan, reasonable planning and course system, optimizing the faculty, reforming of practice teaching base construction, etc., so as to promote the innovative talents training mode which put innovation and entrepreneurship as the background in full swing in business and management.

The report clearly put forward by the party's 18, through improving the independent innovation ability in our country, our country strives for making into an innovative country to 2020. The key for construction of an innovative country is innovative entrepreneurial talent scale and quality, and innovative entrepreneurial talent training depends on the innovation entrepreneurship education of university. 《The education planning program》 also made clear that , should to "firmly establish the center position of talent cultivation in higher education, strive to cultivate faith persistence, and good moral character, knowledge ability ,strong high quality talents and top creative talent". To achieve the value goal and the pursuit of goals, it is necessary to change the traditional single to diversification, homogeneity to personalized creative talent training mode.

The business management specialty construction in institutions of higher learning gain a lot of achievements, but along with our country economic restructuring and the change of social demand, the graduates in the aspects such as practical ability, innovation and entrepreneurship is still obvious deficiencies. The institutions of higher learning as talent training base , Should be to modern means of education, internationalization of the forward-looking perspective, the collaborative strategy of globalization, adhere to the common, Shared and common core values, adhere to the colleges and universities,

discipline, and professional characteristics and deep background, combine the needs of regional economic development, realize high fusion of the theoretical knowledge and practical ability and innovative spirit, training mode and management mechanism innovation as the core, to improve graduate practice ability as the breakthrough point, fully implement the responsibility education talent training concept, vigorously promote the ability to form oriented mode of talent training, which has extremely important practical significance for the business management professional talent training innovative undertaking.

## II. ANALYSIS OF THE SITUATION

At present, the university students' employment is still a the important indicators of admissions for examination and assessment of education quality and the management performance .The current assessment mechanism determines the college aside for this innovative undertaking, excessive attention to cultivate students employment goals. Personnel training mode of Business management professional is not exceptional also, mainly follow the professional skill quality as the core, through the theoretical teaching and experimental teaching to cultivate the students' future employment ability.

Through our investigation of 120 university of industry and commerce management professional, we found that although the vast majority of colleges and universities carry out the business innovation education in different level, but the traditional way of teaching method is still dominant. Teachers are still only with theory teaching, and each module has failed to effectively join and integrate into an organic system, lead to innovative entrepreneurial ability cultivation lodged in an empty theory teaching stage. Investigating its reason, Teachers with innovative entrepreneurial experience quite lack, the phenomenon of heavy theory, light practice led to cannot accurately grasp the essence of innovative undertaking, because of a lack of case

and practice education base, theory and practice is impossible. Even if some of the colleges and universities more emphasis on practice teaching link in business and administration, but the construction of practice base can't keep up with the practical teaching requirements, through our research found theory course in colleges and universities account for a large proportion, and the practical operation of relatively low proportion of courses such as training project. In addition, for entrepreneurs into the classroom or to lecture, 985 and 211 colleges and universities are slightly more than the ordinary colleges and universities, but also unable to satisfy the business management professional students contact the latest innovative entrepreneurial management information under the background of innovation entrepreneurship.

Training program is to cultivate students programmatic document. The study found that the vast majority of colleges and universities on the curriculum, not highlight the important position of education, the plan is still in the employment as the core, the main performance for the lack of comprehensive course, and too many professional courses, main show is lack of comprehensive course, and too many professional courses; the construction of teaching material and update the slow progress; practice curriculum is insufficient, lack of systematic innovation entrepreneurship. Thus affecting the new entrepreneurial talent cultivation.

## III. BUSINESS MANAGEMENT PROFESSIONAL INNOVATIVE ENTREPRENEURIAL TALENT TRAINING SCHEME OF REFORM

In the concept of Innovation entrepreneurship education of industry and commerce management professional talent training target is not clear, according to the general rule of creative education, we should pay attention to the cultivation of innovation ability and entrepreneurial ability [1], as shown in "Figure 1".

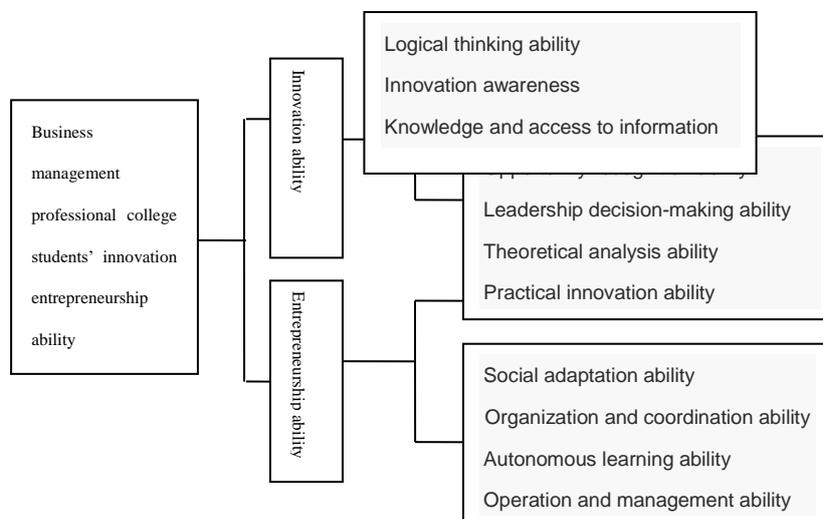


Figure 1. Business management professional college students innovation entrepreneurship ability requirements

About business management professional creative entrepreneurial talents training scheme reform, should be combined with the feature of professional, drawing lessons from the international dvanced ideas and standards such as SIYB ,carry on the omni-directional innovation on the teaching organization, teaching means, teaching subject, learning style, choice of entrepreneurial projects, teaching resources, group guidance, etc. To establish the new training mode of "one goal, two systems, three phases, four methods, five platform", as shown in "Figure 2", and the classification of the "three stage training process" is shown in "Figure 3".

In addition, we should to further optimize the

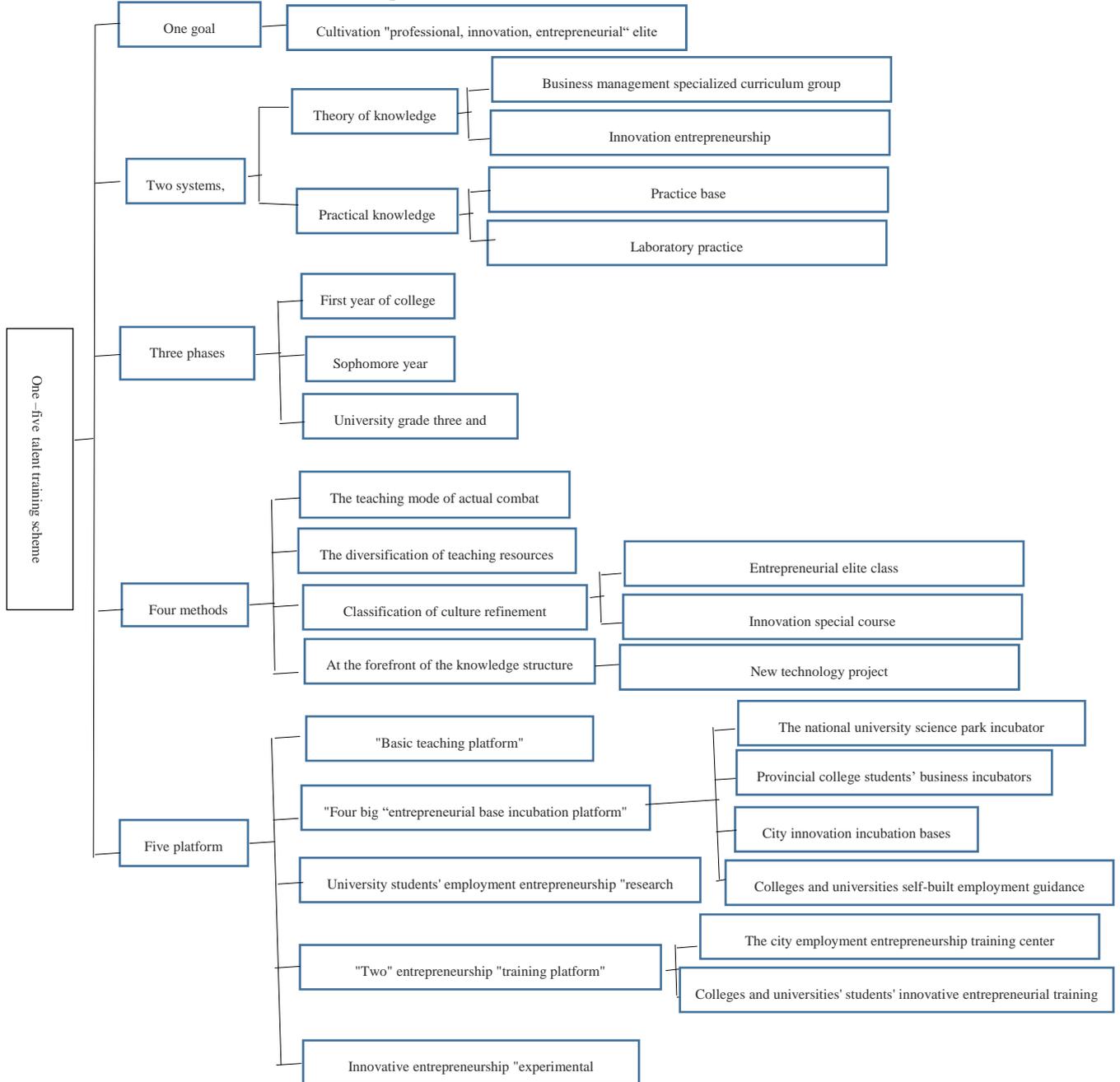


Figure 2. Training scheme design of business management professional

"double levels, two types, multiple model" training scheme, carry on the scientific classification, continuously introduce new concept, design a new model, build a new system, introduce a mechanism. Specific idea is as follows:

A. *The new classification method - science double levels, two types*

We should evaluate student's creative consciousness, ability and interest through the assessment of test questions and simulation reply way, and according to the assessment result carry on classifying more scientific for students' double layers, two types.

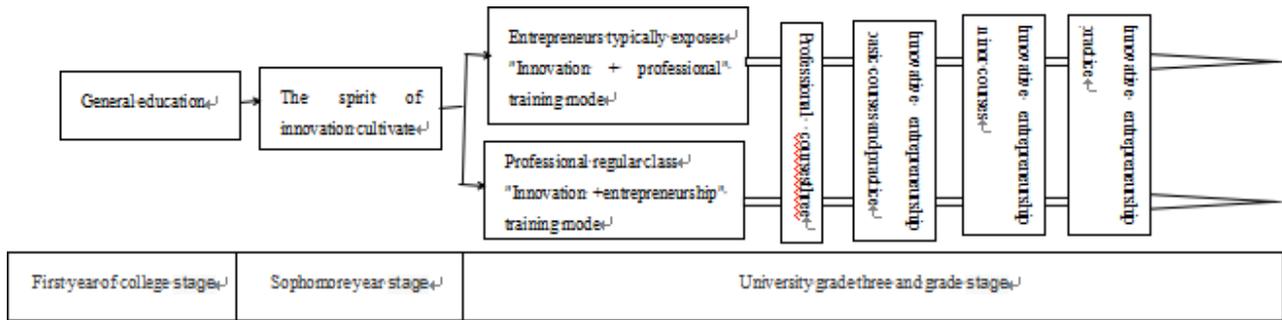


Figure 3. "three stages" training project implementation process

*B. The new cultivation conception-fusion professional education of all-round and the whole process innovative entrepreneurship education.*

Time node, innovation entrepreneurship course will be set in every year of the four years of university ;In classroom teaching, we should use heuristic and more discussion-based teaching methods, encourage students to boldly questioned, have the courage to criticize, cultivate students' creative thinking and pioneering consciousness; In the process of evaluation, we should adopt more innovative class examination proposition, encourage students to think independently, to cultivate the students' skeptical and adventurous spirit, and inspire them to adopt innovative thinking to solve new problems; In practice experiment, graduation thesis and social practice, we should to increase the design of the creative class content, cultivate students' innovation ability.

*C. New teaching mode, multiple perspectives to build the future entrepreneurs growing environment*

The first point of view, inviting outside the entrepreneurs, the school teachers and entrepreneurial team to discuss entrepreneurship case, train team analysis problem, problem-solving ability; Point two, regularly carrying out diathesis developing training, training entrepreneurial teams indomitable character; Point three, the three for each team recommend entrepreneurs, outside the school teachers, joint guidance to its, solve questions in the process of actual operation; To recommend entrepreneurs outside the school and teachers for each team, jointing for its guidance, solving questions in the process of actual operation; Point four, applying to the school office space, office equipment, even stores, to solve the situation that the student team have no fixed abode; Point six, the hired six relevant government personnel on preferential policies granted by the state, provide more support for the team; hiring a relevant government personnel to explain on preferential policies granted by the state, to provide more support for the team; Point of seven, for better developping team, it is recommended to school, city, province start-up incubator park, to provide a broader platform. The practice of this kind of multi-angle, all-round support entrepreneurial teams, facilitate future entrepreneurs thrive.

*D. New course system, optimize and refine the original curriculum system, increase new technology subject*

In a hierarchical, points type training mode foundation, further will further optimize and refine the original curriculum system, highlight the differences of different culture, to achieve the training objectives of characterization. Further to realize thorough optimization and refinement of the original curriculum system, highlight the differences of different culture, achieve the training objectives of characterization. In addition, adding new technology project education, make students understand the relevant professional field of the latest, cutting-edge technology and industry development, expand new field of vision, to help find new market opportunities.

*E. New training mechanism-interdisciplinarity , professional integration, engineering management and engineering work together*

On the choice of entrepreneurial projects, business management professional entrepreneurial teams can use engineering professional patent between teachers and students, and implement nterdisciplinarity and engineering management and engineering work together, promote the development of fusion; Encourage students to match different disciplines professional students, realize professional integration, complementary knowledge, so as to establish the optimal combination of entrepreneurial teams.

**IV. INDUSTRIAL AND COMMERCIAL MANAGEMENT THEORY SYSTEM REFORM ORIENTED INNOVATION AND ENTREPRENEURSHIP**

Relying on the effective carrier of course, to build college students' innovative entrepreneurship education practice. Regarding society and the market demand for talent as the guide, combining its own characteristics, reform and perfect the innovative entrepreneurial talent training mode, set up scientific and reasonable system of curriculum group, reasonably plan the proportion of compulsory courses and elective courses asic course and specialized course, theory and practice class, on the basis of business management carry on effectively curriculum management and the whole

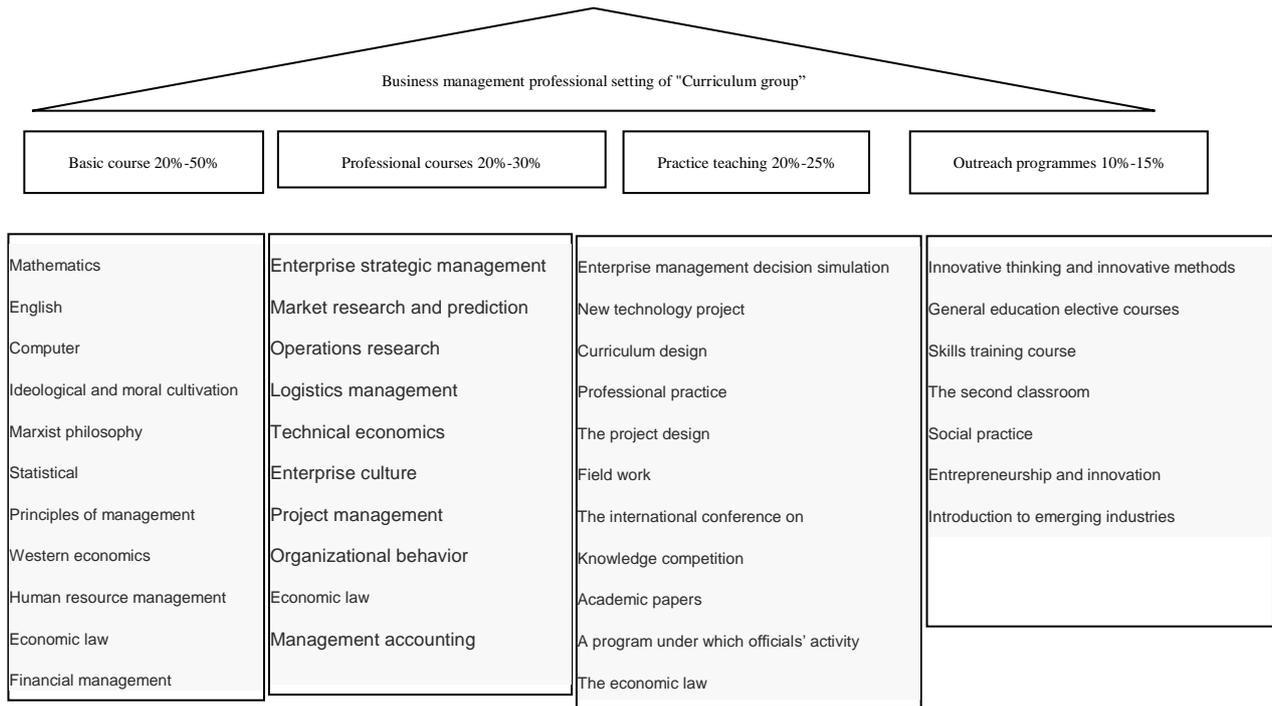


Figure 4. Business management professional setting of "Curriculum group" under the guide of innovation and entrepreneurship

process of monitoring, on the basis of business management carrying on effectively curriculum management and the whole process of monitoring, through teaching further summary and reflection, and constantly adjust and perfect, to ensure that the set of courses in reality and orderly advance at the same time, constantly optimized [1], finally achieve to all-around development and the promotion of the innovation of business management professional students entrepreneurial ability, as shown in "Figure 4".

*A. Industrial and commercial management professional theory course system reconstruction led by innovative undertaking.*

The content of the innovation entrepreneurship education blended into the existing courses in business and management, with content system and course together, work together, thus effectively promote the development of creative education. Some courses should reflect the characteristics of creative education in the teaching process, such as 《management》, 《strategic management》, 《operational research》 combined with practice more closely, should fully embody the characteristics of entrepreneurship education; About practice teaching, we must form a complete set of corresponding practice education base, also want to reflect the financing, profit, cost, market, strategy, management, production, etc in practice process.

*B. Based on the concept of innovative undertaking to conduct entrepreneurship training courses*

Innovative entrepreneurial talent training, the entrepreneurship practice must be integrated into the business management professional training curriculum,

so as to cultivate and enhance students' practical ability. For example in the industry and commerce management professional training courses, we should open "the enterprise management practice", this course makes students understand a firm's operating process, probably at the same time can improve the students' cost, logistics, marketing and other aspects of the use of the knowledge and business practice ability.

**V. THE PRACTICE TEACHING REFORM OF ENTREPRENEURIAL INNOVATION ORIENTED**

Enhancing university-enterprise cooperation, and establishing off-campus practice base. Industry and commerce management professional practice teaching reform regard innovation and entrepreneurship as the guidance, with the aid of university-enterprise cooperation platform, let the students go deep into enterprise, profound understanding enterprise each department's operation process, through autonomous learning, self-analysis, constantly summary to improve students' creative thinking at the same time. Use of geographical advantages, we can found campus practice base. Independent operation and management by the students, enrich the students' practice. We can also through the development of the social survey, invite entrepreneurs or successful entrepreneurs to school lectures, or use of network platform, not limited to time, place and space, and the student to carry on the online practice guidance, interaction and sharing experience, etc with student. In addition, innovative entrepreneurship competition were extensively developed, which can inspire students' innovative entrepreneurial potential, this is very important to improve practice and innovation ability.

#### A. *The standardization of the teaching experiment.*

Setting up business management innovation entrepreneurship oriented experimental teaching platform, through innovative business processes, management decision-making simulation training, students can experience the different responsibility and way of thinking. At the same time, teachers, students and the real enterprises can jointly develop teaching software which adapt to the need of innovative entrepreneurial education experiment teaching requirements.

#### B. *Business management professional personnel training mode innovative undertaking need multilateral mutual support.*

Setting up in colleges and universities, the local government and the real enterprise tripartite cooperation platform is imperative. First of all, colleges and universities should actively obtain relevant government innovation entrepreneurship preferential policies, including capital injection, human support and policy inclination, a joint collaboration business management professional college students' innovative entrepreneurial platform including facilities and guidance mechanism. Second, we should reduce the risk of business management professional college students' innovative undertaking, and subsequent security system must be established, such as unemployment insurance, health care, etc. Third, we should build a university-enterprise cooperation platform, adhere to the win-win concept of cooperation, build and perfect the bidirectional interaction mechanism of university-enterprise cooperation. Through the university-enterprise cooperation, Colleges and universities to the enterprise demand of choose and employ persons have a clear understanding, on this basis, to provide innovative entrepreneurial experience, exercise its innovation ability; On the other hand, enterprises can pass mechanisms of "industry-university-institute Jin Jieyong politics and collaborative innovation", apply the latest research results in colleges and universities to the enterprise, to improve the efficiency of enterprises.

### VI. THE WAY OF TEACHING AND EXAMINATION MODE REFORM TAKING ENTREPRENEURIAL INNOVATION AS THE ORIENTATION

In today when innovative entrepreneurship has become increasingly popular, according to the different course nature, the business management major should introduce a variety of forms, reform different teaching methods reform, draw lessons from foreign universities as much as possible in this advanced advantage, learn diversified teaching methods, with the help of the teaching methods, improve the students' ability of autonomous learning. On basis of professional course, we should adopt heuristic teaching is introduced into the problem, in the form of seminars to inspire students to think and read widely, cultivate students independent

inquisition ability and analysis ability to solve problems. For practice teaching, expanding course which has the characteristics of strong practicality, and can take the role playing+group projects+case discussion and so on the many kinds of interactive teaching method, expand students' thinking, enhance students' operation ability and cultivate students' team cooperation ability, innovation ability and practice ability. About the reform of teaching methods and means, we specific can adopt the following several kinds:

1) Problem-based teaching. For new things, new methods and new phenomenon, we can use questions, inquiry and asked, constant scrutiny and guide students to think, to inspire students' innovative thinking.

2) All courses through case teaching. In the business management specialized curriculum teaching, we should take students as the main body, through the typical business case discussion, simulation, lets the student can apply learning theory to practice.

3) Interactive teaching. Mainly involves teachers teaching, students participate in and positive thinking, and on this basis, students raise questions as far as themselves grasping knowledge, observing new things, new phenomena and so on ,and proceed the collective or group discussion, student representatives speak in the last .

4) Scenario simulation method. With the aid of network platform, in role playing, we can simulate related practice of reality enterprise operation and management's whole process, and enhance students' practical ability [2].

5) Double type teaching mode. Industrial and commercial management professional teachers' academic level of theory is relatively strong, but they rarely contact for innovative entrepreneurial practice. Therefore, teaching purpose, model, ability training in such aspects cannot completely adapt to actual requirements of the development of innovative entrepreneurship education today. Innovative undertaking is a continuous process, only teachers innovation can cultivate students innovation. Industrial and commercial management should first introduce double can talent to make up for the defect of teachers in innovation entrepreneurship .Secondly, teachers should be encouraged to field work, enhance the teacher's practice ability. Third, industry and commerce management major should be actively with international practice, especially in terms of innovative entrepreneurship education increasing investment, continuous conveying outstanding teachers to foreign to proceed innovate entrepreneurship education in colleges and universities for further study.

6) Reforming the traditional examination way. At present, in terms of curriculum, the traditional examination way still is given priority to with closed-book exam , students in the process of problem solving accept and imitate acquired knowledge and blindly follow the standard answer, and lose his own perspective and innovation consciousness. Business

management professional, therefore, must reform the traditional performance appraisal way, and give priority to in order to process, mainly excavating methods and ideas of students to solve practical problems [3].

#### VII. Reforming the teaching contents taking the innovation entrepreneurship as a guide

Under the background of innovation entrepreneurship, business management professional talent training mode reform, should focus on innovative entrepreneurial quality and ability training. Considering characteristics of major of industrial and commercial management, we should scientifically set up basic course and specialized course, practice course and expand their proportion. we should pay attention to the use of innovative entrepreneurial knowledge and skills in the process of practice teaching, from the perspective of reality, as far as possible involve all kinds of problems met in enterprise operation process, such as marketing, production management, strategic management, human resource management and financial management module, and by actual combat scenario, focus on training students how to discover problems, on this basis, through the further analysis and mining, eventually forming the ability of solution to the problem. we can use of practice teaching course, expansion courses extend students' creative ability, and through mutual penetration of the second class+social practice+ skill training and other practical and interdisciplinary, train the student to practice creative consciousness and comprehensive quality.

#### VIII. The cultivation evaluation taking the innovative undertaking as orientation.

Training evaluation is the final link of talent cultivation. The establishment of a set of evaluation methods and standards adapted to the training target, training process, training system can ensure the training goal complete and implement smoothly. Colleges and universities industrial and commercial management major should be in the aspect of the talent cultivation evaluation, in order to enhance students' innovative ability and the innovative ideas of teachers teaching goals, improve and optimize the evaluation content constantly. That specific involved in the development and construction of related courses, reform of teaching methods and the ascension of scientific research level and cooperation capacity, management method and the method of improvement of evaluation mechanism in system, and continue to strengthen business management specialized on the cultivation of the students' ability of innovation and entrepreneurship [4].

In short, business management professional talent training mode reform in colleges and universities taking innovation business as orientation is a complicated system engineering. We should be accordance with the requirements of strategy to build an innovation-oriented country, in order to cultivate the

innovative entrepreneurial talent as the mission, in order to enhance students' innovative ability as the core, to cultivate students' innovative spirit+innovative thinking+ innovative ability + innovative personality as the basic value orientation, to exploit people's creative potential, promote the harmonious development of personality for the purpose, to follow the law of education development, pay attention to new courses to develop students' innovative ability and entrepreneurial ability, to take zheng Jin Jieyong and collaborative innovation of industry as cooperation mechanism, closing ties between government and enterprise, taking the openness and diversity as a characteristic, adjusting and reform the training target, training process, training system, training evaluation on time, focusing on cultivating innovative ability and entrepreneurial ability, innovation quality, innovation consciousness as a whole of the innovative entrepreneurial talent in business and management, to constantly meet the social demand for innovative entrepreneurial talent in business and administration.

#### ACKNOWLEDGMENT

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# Study on Intervention in Undergraduates' Social Communication Anxiety with Drama Therapy

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**Abstract**—Drama therapy is an emerging psychotherapy mode. It combines medical science, psychology, drama performance and sociology etc. and shows significant effects on treating various psychological diseases. Through adopting symptom check list of extensive outpatient examination of dysphrenia and psychological diseases - SCL-90, social avoidance and distress scale (SAD), interaction anxiousness scale (IAS), shyness scale, and SPSS20.0 data processing software etc. as research tools, drama therapy was applied to intervene in undergraduates with social communication anxiety. The experimental data show that the experimental group has significant difference before and after the intervention. Thus, drama therapy is a new approach which can effectively intervene in undergraduates' social communication anxiety.

**Index Terms**—drama therapy, undergraduate, social communication anxiety, intervention mode

## I. STATEMENT OF QUESTIONS AND RESEARCH HYPOTHESES

### A. Statement of questions

In today's society, good sociability is not only a prerequisite for personal success, but also an important criterion for measuring the mental health of individuals. Undergraduate stage is an important period for personality perfection and psychological maturity, and undergraduates are faced with pressure from learning, living and employment, hence they may feel a strong contrast between ideal and reality and are more prone to suffer from social communication anxiety. A survey of 223 British undergraduates carried out in 1970s found that 10% of the undergraduates have social difficulties or avoidance behavior in a social situation. At the same time, a sample survey carried out in American undergraduates found that 42% of the students describe themselves as shy. [1] Researches show that the average score of interpersonal sensitivity factor of students in the age group of 18-19 years is the highest, anxiety score in this age group is also the highest. [2] A survey carried out in Hunan colleges and universities by Peng Chunzi et al. shows that: "About 16.26% of the undergraduates have serious social communication anxiety." [3] As can be seen from these studies, social communication anxiety is a prominent

problem for undergraduates and has a significant negative impact on their physical and mental health.

At present, drug therapy is the key therapy against social communication anxiety, but drugs can only relieve the illness temporarily, and most drugs have side physical effects, hence it is not worth promoting. With the transition of medical model from biological model to biological-psychological-social model, in addition to drug control, drama therapy has been accepted in clinics due to its safety and favorable effect, which is especially suitable for groups suffering from emotional disturbances. Currently, there are few domestic studies on drama therapy, empirical studies on improving undergraduates' social communication anxiety by using drama therapy are yet to be made. The application of drama therapy in Chinese studies on intervention in undergraduates' social communication anxiety can not only help to improve social communication anxiety, but also can promote physical and mental health as well as harmonious interpersonal relationship among undergraduates, which further expands the application category of drama therapy in Chinese psychological studies to a certain extent.

### B. Research hypotheses

- (1) The scores of pretest experimental group and the control group in SCL-90 symptom scale, SAD, IAS and Shyness Scale were basically consistent.
- (2) The indexes of post-test experimental group in SCL-90 symptom scale, SAD, IAS and Shyness Scale dropped, anxiety factor improved significantly and interpersonal skills improved.
- (3) The indexes of post-test control group in SCL-90 symptom scale, SAD, IAS and Shyness Scale did not improve significantly.
- (4) Drama therapy had a positive effect on the intervention in undergraduates' social communication anxiety, enabling those undergraduates to learn emotional management and to enhance sociability.

## II. RESEARCH OBJECTS AND METHODS

### A. Research objects

The research objects are screened out from undergraduates in a Hunan university, with 32 volunteers, 9 males and 23 females with an average age between 18-21, their total SAD test scores are higher

than 13, wherein anxiety scores are higher than 7 and avoidance scores are higher than 12. The 32 people are randomly divided into an experimental group and a control group, each group consists of 16 people. The experimental group conducts social communication anxiety intervention by using drama therapy, and the control group does not make any intervention.

## B. Research methods

### 1. Research tools

SCL-90 symptom scale is currently the most widely applied outpatient examination scale of psychological diseases and dysphrenia, with good reliability and validity reports. The scale is divided into 9 subscales, a total of 90 entries, respectively are somatization, obsession, sensitivity of interpersonal relationship, depression, anxiety, hostility, fear, paranoia, psychosis and other 10 factors. 5-level scoring is adopted, symptoms are rated as 1, 2, 3, 4, 5 from none to severe, and the higher scores indicate more severe symptoms and lower level of mental health.

SAD was first compiled by professors Watson and Friend in 1969 and was used to measure the patient's possible behavior and social distress in interpersonal communication. The scale has a total of 28 entries, wherein 14 are used for the assessment of social avoidance and 14 for social distress; Answer questions with "Yes-No", scores range from 0 to 28, the higher the score, the higher the degree of social avoidance and distress; Cronbach  $\alpha$  coefficients of the two subscales are 0.85 and 0.87, respectively. [4]

IAS was compiled by Leary and was used to measure the subjective social communication anxiety tendency independent from behavior. The scale has a total of 15 entries; 5-level scoring is adopted, scores range from 15 (the lowest degree of social communication anxiety) to 75 (the highest degree of social communication anxiety). The scale has good reliability and validity, with Cronbach  $\alpha$  exceeding 0.87. [5]

Shyness Scale currently has 13 widely used entries of revised scales, scores range from 13 (the lowest shyness degree) to 65 (the highest shyness degree). Cronbach  $\alpha$  coefficient of the scale is 0.90, test-retest reliability after 45 days is 0.88. [6]

Data statistics analysis tool used in this study is SPSS20.0 statistical package.

### 2. Research methods

Some researchers distributed SCL-90 symptom scale, SAD, IAS and Shyness Scale to research objects using the same instructions, research objects need to carefully fill in and make assessments. After assessment, 32 research objects are randomly divided into a control group and an experimental group. The control group does not receive any intervention; the experimental group receives 10 times of drama therapy, two hours each time and one time a week. The drama therapy received by the experimental group is a group drama therapy activity, it is divided into three stages. The first stage (1<sup>th</sup>-2<sup>nd</sup> time) is group formation stage, which helps group members to relax and build mutual

trust by saying "I love you, you do not love me", rhythmical physical activities like train games and trust sense games, etc. The second stage (3<sup>rd</sup>-9<sup>th</sup> time) is group development stage, which aims at promoting group members' self-exploration and self-development. At this stage, drama therapies such as telling story, sculpturing, mask making, role-playing are applied to guide members to perceive their anxiety mood in social contact, discuss internal factors of social communication anxiety, promote exchanges among members and establish confidence in contact. The third stage (10<sup>th</sup> time) is closing stage, which guides members to review the mood changes during anxiety, share experiences after participating in drama therapy activities and encourage them to generalize their behavior of full expression of self-perception in therapeutic activities to everyday life. After 10 weeks, researchers enter all the data into computer after collecting the pretest scales filled in by the 2 groups of research objects, and a t-test analysis is conducted using a professional data statistics analysis tool.

## III. RESULTS AND ANALYSIS

### A. Comparative analysis of index values of the two pretest experimental groups

An independent sample t-test of scales of the control group and experimental group before the experiment is conducted, see table I.

T-test results in the above table show that the T values comparing factors of hostility, neurosis, SCL-90, etc. of the two groups irrelevant to social communication anxiety in SCL-90 symptom scale are 2.546, -3.624 and 2.298, respectively, the corresponding P values are less than 0.05, with significant statistical significance, indicating that the hostility, mental diseases, SCL-90 of the two groups have significant difference. Other indexes of the two groups before experiment have no significant difference (the corresponding P value is greater than 0.05), indicating that the two groups are basically at the same level before the experiment, comparison between the intervention effect of the two groups can be made on this basis.

### B. Comparative analysis of index values of the control group before and after the experiment

An independent sample t-test is conducted for scales of the control group before and after the experiment, see Table II.

To examine the changes of social communication anxiety level before and after the experiment, we conducted a t-test (Table II) of the scale scores of the control group before and after the experiment. t-test results in the above table show that the P values corresponding to T values comparing indexes of the control group before and after the experiment are all greater than 0.05, with no statistical significance, indicating that the index values of the control group before and after the experiment have no significant difference.

TABLE I

COMPARATIVE ANALYSIS OF INDEX VALUES OF THE TWO PRETEST EXPERIMENTAL GROUPS (X ±S)

	Control group (n=8)	Experimental group (n=8)	T value	P value
Somatization	9.13±1.55	7.88±1.36	1.715	0.108
Sensitivity of interpersonal relationship	15.00±1.07	14.13±1.89	1.142	0.273
Obsession	12.50±1.85	13.63±1.92	-1.192	0.253
Depression	16.00±0.93	15.63±1.30	0.664	0.518
Anxiety	15.75±2.25	14.38±2.07	1.273	0.224
Hostility	7.75±1.04	6.50±0.93	2.546	0.023*
Fear	6.25±1.39	5.63±1.06	1.012	0.329
Paranoia	7.75±0.89	8.50±0.93	-1.655	0.120
Mental diseases	6.63±1.19	9.25±1.67	-3.624	0.003**
Other	7.13±1.25	6.88±1.25	0.401	0.694
SCL-90	106.63±3.58	102.13±4.22	2.298	0.037*
SAD social avoidance	12.00±0.76	11.88±1.73	0.188	0.854
SAD social distress	10.63±1.69	10.13±1.25	0.675	0.511
Total SAD	22.63±1.41	22.00±1.60	0.828	0.421
IAS	54.13±2.03	54.75±2.60	-0.535	0.601
Shyness Scale	27.88±1.81	27.13±1.56	0.615	0.388

(Note: \* indicates that P value is less than 0.05, with significant difference; \*\* indicates that P value is less than 0.01, with very significant difference)

TABLE II

COMPARATIVE ANALYSIS OF INDEX VALUES OF THE CONTROL GROUP BEFORE AND AFTER THE EXPERIMENT (X ±S)

	Before experiment (n=8)	After experiment (n=8)	T value	P value
Somatization	9.13±1.55	8.63±2.33	0.552	0.598
Sensitivity of interpersonal relationship	15.00±1.07	15.88±1.89	-0.977	0.361
Obsession	12.50±1.85	12.38±1.69	0.243	0.815
Depression	16.00±0.93	15.63±1.19	0.893	0.402
Anxiety	15.75±2.25	16.50±0.93	-0.814	0.442
Hostility	7.75±1.04	7.63±1.41	0.205	0.844
Fear	6.25±1.39	6.38±1.41	-0.243	0.815
Paranoia	7.75±0.89	7.25±0.71	1.000	0.351
Mental diseases	6.63±1.19	6.63±1.51	0.000	1.000
Other	7.13±1.25	7.25±1.49	-0.357	0.732
SCL-90	106.63±3.58	105.88±1.96	0.716	0.497
SAD social avoidance	12.00±0.76	11.38±1.30	1.357	0.217
SAD social distress	10.63±1.69	10.38±1.06	0.683	0.516
Total SAD	22.63±1.41	21.75±1.67	2.198	0.064
IAS	54.00±1.85	54.88±1.25	-1.986	0.087
Shyness Scale	27.88±1.81	28.13±1.25	-0.798	0.451

(Note: \* indicates that P value is less than 0.05, with significant difference; \*\* indicates that P value is less than 0.01, with very significant difference)

C. Comparative analysis of index values of the experimental group before and after the experiment

A paired sample t-test is conducted for scales of the experimental group before and after the experiment, see table III.

To examine the therapeutic effect of drama therapy on social communication anxiety, we conducted a t-test of the scale scores of the experimental group before and after the intervention. t-test results in the above table show that the T values comparing indexes of the experimental group before and after the experiment are 9.165, 18.205, 10.315, 25.276, 13.133, 9.000, 4.965,

9.029, 7.483, 3.274, 55.914, 13.015, 13.133, 16.594, 9.128, 23.664, respectively, the corresponding P values are all less than 0.05, with significant statistical significance, indicating that the index values of experimental group before and after the experiment have significant difference. The index values of the experimental group after the experiment are significantly lower than before the experiment, indicating that drama therapy significantly improved the social communication anxiety level of undergraduates.

TABLE III

COMPARATIVE ANALYSIS OF INDEX VALUES OF THE EXPERIMENTAL GROUP BEFORE AND AFTER THE EXPERIMENT ( $\bar{X} \pm s$ )

	Before experiment (n=8)	After experiment (n=8)	T value	P value
Somatization	7.88±1.36	4.88±1.36	9.165	0.000**
Sensitivity of interpersonal relationship	14.13±1.89	5.88±1.25	18.205	0.000**
Obsession	13.63±1.92	6.75±1.28	10.315	0.000**
Depression	15.63±1.30	6.38±0.92	25.276	0.000**
Anxiety	14.38±2.07	6.63±1.51	13.133	0.000**
Hostility	6.50±0.93	4.25±1.04	9.000	0.000**
Fear	5.63±1.06	4.50±1.07	4.965	0.002**
Paranoia	8.50±0.93	6.13±0.83	9.029	0.000**
Mental diseases	9.25±1.67	7.25±1.49	7.483	0.000**
Other	6.63±1.60	5.25±1.04	3.274	0.014*
SCL-90	102.13±4.22	58.00±3.12	55.914	0.000**
SAD social avoidance	11.88±1.73	6.38±0.74	13.015	0.000**
SAD social distress	10.13±1.25	6.25±1.28	13.133	0.000**
Total SAD	22.00±1.60	12.63±1.06	16.594	0.000**
IAS	54.75±2.60	44.13±2.53	9.128	0.000**
Shyness Scale	27.13±1.56	17.13±1.26	23.664	0.000**

(Note: \* indicates that P value is less than 0.05, with significant difference; \*\* indicates that P value is less than 0.01, with very significant difference)

TABLE IV

COMPARATIVE ANALYSIS OF INDEX VALUES OF THE TWO POST-TEST EXPERIMENTAL GROUPS ( $\bar{X} \pm s$ )

	Control group (n=8)	Experimental group (n=8)	T value	P value
Somatization	8.63±2.33	4.88±1.36	3.939	0.001**
Sensitivity of interpersonal relationship	15.88±1.89	5.88±1.25	12.962	0.000**
Obsession	12.38±1.69	6.75±1.28	7.515	0.000**
Depression	15.63±1.19	6.38±0.92	17.442	0.000**
Anxiety	16.50±0.93	6.63±1.51	15.800	0.000**
Hostility	7.63±1.41	4.25±1.04	5.463	0.000**
Fear	6.38±1.41	4.50±1.07	3.000	0.010*
Paranoia	7.25±0.71	6.13±0.83	3.035	0.009**
Mental diseases	6.63±1.51	7.25±1.49	-0.835	0.418
Other	7.25±1.49	5.25±1.04	3.121	0.008**
SCL-90	105.88±1.96	58.00±3.12	36.781	0.000**
SAD social avoidance	10.38±1.06	6.25±1.28	7.013	0.000**
SAD social distress	21.75±1.67	12.63±1.06	13.051	0.000**
Total SAD	11.38±1.30	6.38±0.74	9.428	0.000**
IAS	54.88±1.25	44.13±2.53	10.774	0.000**
Shyness Scale	28.13±1.25	17.13±1.26	18.407	0.000**

(Note: \* indicates that P value is less than 0.05, with significant difference; \*\* indicates that P value is less than 0.01, with very significant difference)

#### D. Comparative analysis of index values of the two post-test experimental groups

A paired sample t-test is conducted for scales of the control group and the experimental group after the experiment, see table IV.

T-test results in the above table show that the mental diseases factor of the two groups after experiment have no significant difference (the corresponding P value is greater than 0.05). T values comparing somatization,

interpersonal relationship, obsession, depression, anxiety, hostility, fear, paranoia, other, SCL-90, SAD social avoidance, SAD social distress, Total SAD, IAS, Shyness Scale of the two groups are 3.939, 12.962, 7.515, 17.442, 15.800, 5.463, 3.000, 3.035, 3.121, 36.781, 9.428, 7.013, 13.051, 10.774, 18.407, respectively, the corresponding P values are all less than 0.05, with significant statistical significance, indicating that somatization, interpersonal relationship, obsession, depression, anxiety, hostility, fear, paranoia,

other, SCL-90, SAD social avoidance, SAD, social distress, Total SAD, IAS, Shyness Scale of the two groups have significant difference. In addition to the mental diseases index of the experimental group after the experiment, other indexes are significantly lower than that of the control group.

As can be seen from the above data analysis, after 10 weeks of drama therapy intervention, there had a significant difference of changes in the level of mental health, social avoidance, social distress, contact anxiety and shyness of the control group as well as the experimental group, the score of the experimental group dropped significantly, factors of mental health level also showed some improvements.

#### IV. DISCUSSION

##### A. *Performance Assessment of Drama Therapy Intervention in Undergraduates' Social Communication Anxiety*

The excessive attention and unitary conversation of traditional psychotherapy can easily lead to undergraduates' resentment or even psychological inversion accompanied by acts of resistance. However, drama therapy can attract patients to complete therapy unknowingly by using its rich forms of entertainment. Assessment of the intervention effect shall not only inspect the changes of social communication anxiety symptoms, but also conduct a comprehensive assessment. This study conducts a comprehensive assessment of the therapeutic intervention effect from the level of mental health, social avoidance, social distress, contact anxiety and shyness level and other aspects, and achieved good results. As can be seen from the experiment results, whether compared to the control group or the pretest experimental group, the experimental group received drama therapy has a significant improvement on level of mental health, social avoidance, social distress, contact anxiety and shyness level.

##### B. *Functional mechanism of drama therapy intervention mode on undergraduates' social communication anxiety*

###### 1. Emotional support gained from group

1) Find commonality. Drama performance is performed in a collective form and requires participants to live in harmony, which objectively provides interaction and communication opportunities among patients. Many undergraduates are ashamed when experiencing psychological problems on account of their young age, and they are under great mental suffering with no ability to resolve, further affecting their normal life seriously. In the process of drama therapy, people will gain a sense of ease, and are no longer embarrassed to expose their mental activity by playing or watching the characters with similar experiences and encounters to them, thus finding commonality with the characters or other members, relaxing themselves and reducing defensiveness.

2) Group acceptance. The basis of all intervention

lies in group acceptance, and acceptance is derived from the guiding philosophy of humanism as well as the cohesion formed in the interactive process of members. Group acceptance produces a respectful, harmonious and warm atmosphere in which members feel a safe atmosphere of interpersonal relationship, not afraid of the negative evaluation from other people, and have the courage to try diversified behaviors, cognitive and emotional ways of expression. Meanwhile, the acceptance degree of others also marks the openness of one's heart, the mutual trust established among members in drama therapy and the true understanding of others, thus opening one's heart to accept themselves and others.

###### 2. Emotional drainage

Everyone will encounter setbacks in life and may have no chance to talk to others, which would have adverse effect on physical and mental health by depressing one's distresses in heart. Therefore, emotional drainage is very important in daily life. Social communication anxiety mainly refers to the continuous and significant fearing emotions generated by the presence of strangers or by others on social occasions, which affects one's normal life. Most people will have a sense of tension with strangers, which is a normal reaction, but with in-depth exchanges the tension will gradually disappear and one will enjoy the pleasure brought by the contact. However, the anxiety and fear of people who suffer from social communication anxiety will persist. In drama therapy, the therapist provides an unavoidable anxiety situation (group) by carrying out drama rehearsals with patients, and alleviates social communication anxiety by playing the wished perfect behavior through role-playing as well as actual playing, namely contact-forming behavior.

In drama therapy, the therapist plays a role of scriptwriter and director, and the patient plays the actor. As in drama performance, patients drain emotions, express anxiety, depression and other emotions unscrupulously under the "protection" of the role. In this safe environment, patients' real emotions can be exposed and other members can also better understand each other's mental state, so as to better support each other, help each other out of the dilemma and achieve self-growth.

###### 3. Self-therapy

In traditional psychotherapy, usually it is the therapist who finds problems of patients, then explain the problems and instruct solutions to the patient. Due to the passivity, patients' initiatives and positivity are not high. Although passive therapy can help patients solve problems, whether patients' ability to find problems or to turn understanding into consciousness is inferior to the way of patients' self-therapy. In drama therapy, the therapist does not directly point out the problem of patients, nor explicitly instruct solutions to patients, rather he lets the patient to comprehend the role, release themselves in drama activities, express emotions hidden in the heart, look at themselves, and

explore the way out of social communication anxiety dilemma. "Unlike traditional therapies that inform the patient with problems by using language directly, drama therapy inspires patients to examine their own personality mechanism, personality traits, social relations and interpersonal relationship interaction, etc. by using signs, symbols, metaphors." [7] The self-exploration of patients after receiving the therapist's inspiration is more easily accessible to the depth where outsiders cannot reach, the conclusion arising from this profound self-examination has a high accuracy. The patients proceed self-therapy via signs, symbols, metaphors and other implicit cues, and are more confident to face social situations while achieving self-growth and further overcoming social communication anxiety.

#### V. CONCLUSION

The scores of the experimental group in SCL-90 symptom scale, social avoidance and distress scale, interaction anxiousness scale and Shyness Scale have a significant difference before and after the intervention of drama therapy. The control group has no significant difference between pretest and post-test. The correlating factor scores of social communication anxiety in pretest scales of the control group and the experimental group have no significant difference, and have significant difference in post-test scales. Viewing from short-term effect, the drama therapy intervention mode can effectively improve undergraduates' social communication anxiety. The application of drama

therapy in undergraduates' social communication anxiety can not only be taken as a self-help intervention mode in undergraduates' anxiety or other psychological problems, but also can provide a new reference for students' psychological counseling, school mental health education and other fields.

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# RVM-BASED Urban Hourly Water Consumption Forecasting Model and Its Application

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**Abstract**—In view of the existing problems in urban hourly water consumption, traditional forecasting methods such as neural networks, moving arithmetic mean method are adopted frequently. But these models are short of necessary probability information which likely cause greater error. In this paper, a new forecasting model is proposed based on relevance vector machine (RVM) according to the actual water consumption situation of Zhengzhou city. Test results show that the proposed method has superior non-linear forecasting ability, higher precision of prediction and can be used for the optimal scheduling of water supply.

**Index terms**—urban water consumption model, neural network, urban water supply system, RVM

## I. INTRODUCTION

Urban water supply system is the infrastructure of a city development, the protection of people's daily lives and the indispensable material conditions of social development, production and construction. The people put higher requirements for water supply system and the problems of water supply have become a focus with the acceleration of urbanization process, as well as improvement of living standards and development of social productivity. Urban water forecast can be divided into long-term forecast and short-term forecast according to time [1]. Long-term forecast is based mainly on the growth of economy and population to forecast the water consumption in the next few years, more than ten years or ever longer, and served as urban water supply system's conversion and expansion, and the city's overall construction plan. Short-term forecast is mainly based on historical data of water consumption and the factors which affect the water consumption to predict the future water consumption of one day, one week or several weeks. It's the part of network analysis and optimal scheduling, and it plays an important role. Its prediction precision has a direct impact on the reliability and practicality of water supply optimal scheduling and decision making. It's difficult to use function to describe the water supply system, for many factors with strong randomness [2]

affect the water consumption. So, we must establish a simple and practical prediction model of urban water consumption to achieve scientific and accurate result. [3-4] In this paper, short-term water consumption forecast models have been built using the data of Zhengzhou city water consumption and meteorology, and use the built models to do a simulation experiment.

## II. ANALYSIS OF THE TRADITIONAL URBAN WATER CONSUMPTION FORECAST MODEL

Generally, urban water consumption forecast methods can be divided into two types, namely, interpretative method and forecast time series analysis method, according to the urban water consumption characteristics and its influencing factors. In recent years, artificial neural network, genetic algorithm, Markow method, wavelet analysis and other methods have been used to predict urban water consumption, for these methods can deal with strong non-linear problems. They have been applied in urban water consumption forecast, and have good forecast result. [6-9]

### A. Moving arithmetic method

Moving arithmetic mean method is one type of exponential smoothing method which belongs to time series method. It's can be expressed as:

$$x_{t+1} = \frac{1}{n}(x_t + x_{t-1} + \dots + x_{t-n+1}) \quad (1)$$

Notes:

$x_{t+1}$ : Predictive value of t+1's period;

$x_t$ : The observation value of t's period;

$n$ : The period which used to predict.

### B. Regression analysis modes

Regression analysis forecast model has been built using multiple linear regression analysis, according the collected data which include holiday factors, meteorological factors (the highest and lowest temperature of the forecast day) and the former period value of hourly urban water consumption.

$Q = A_0 + A_1 T_{\max} + A_2 T_{\min} + A_3 W + A_4 H + \varepsilon$   
 Notes:  
 Q -- Observation value of one period water consumption. It's the function of the former period water consumption, the highest temperature of the forecast day, the lowest day temperature of forecast day and the date type value, by excluding other factors.  
 --  $A_0, A_1, A_2, A_3, A_4$  The corresponding

regression coefficients.  $A_0$  is a constant which can be interpreted as the average water consumption. The other factors adjust according to its impact strength.  $A_1, A_2, A_3, A_4$  are influencing factors which reflect the impact strength to water consumption by the corresponding coefficients.  
 $T_{\max}, T_{\min}$  -- The highest temperature and the day lowest temperature the forecast day.  
 W -- Water consumption of the former period.  
 H -- Type of the date. It is defined as three kind values such as 1 which for the common work days, 2 for common weekend and 3 for special holiday such as May Day, the Spring Festival.  
 $\varepsilon$  -- It is the random fluctuation produced by the impact factors which can't be included in the model.

C. BP neural network model

Network structure is built according to the collected data using the ripe BP neural network. The overall network structure is divided into 4 layers, that is, one input layer, two hidden layers and one output layer. The built network is homogeneous network which means that all the artificial neurons use the same driving function. Neurons are been fully connected between neighboring layers, but non-connected at all among non-neighboring layers.  
 Input layer has five neurons. One neuron is for offset, the other four ones are inputs which are the previous period water consumption, the highest temperature of the forecast day, the lowest temperature of the forecast day and the date type value which is the same as regression analysis model. The neurons in hidden layers are fully connected, and S activation function has been selected.

III. RELEVANCE VECTOR MACHINE FORECASTING MODEL

Relevance vector machine is a sparse Probability model based on support vector machine proposed by Michael E Tipping in 2001. Its training is carried on under Bayesian framework, so we can get the distribution of predicted values by regression estimate with RVM. Compared with SVM, RVM has the following advantages [5]:

- (1) With RVM, we can get probability forecasts;
- (2) In the inference process, setting error parameter subjectively can be avoided;

- (3) The relevant vectors used for training are less than the SVM;
- (4) Kernel function has greater range of choices for it need not satisfy the Mercer conditions.

The biggest difference between RVM and SVM is that RVM turns subjective division into objective division under probability, which makes classification function reach likelihood function maximum for the training set.

The output of RVM model is as follows:

$$y(x) = \sum_{j=1}^m \omega_j \phi_j(x) + \omega_0$$

Where  $\phi_j(x)$  is non-linear kernel function,  $\omega_j$  is model weights. The kernel function used in SVM must satisfy Mercer theorem but RVM has not the limitation. After defining the model (1) basis functions, we can train the model weights  $\omega_j$  with maximum likelihood method under Bayesian framework, which may avoid learning problems and improve model generalization ability. Therefore, RVM defines priori probability distribution for each model weight:

$$p(\omega_j | \alpha_j) = \left[ \frac{\alpha_j}{2\pi} \right]^{1/2} \exp \left[ -\frac{1}{2} \alpha_j \omega_j^2 \right] \quad (2)$$

Where  $\omega_j$  is hyper-parameter of the priori distribution of model weight  $\alpha_j$ . For a given set of training samples  $\{x_i, t_i\}_{i=1}^N$ , Assume that the target value  $t_i$  is independent, and the noise of input data obey Gaussian distribution of which the variance is  $\sigma^2$ . In this way, likelihood function of the given training samples set is as follows:

$$p(t | \omega, \sigma^2) = (2\pi\sigma^2)^{-N/2} \exp \left[ -\frac{1}{2\sigma^2} \|t - \Phi\omega\|^2 \right] \quad (3)$$

Where  $t = (t_1, t_2, \dots, t_N)^T$ ,  $\omega = (\omega_1, \omega_2, \dots, \omega_N)^T$ ,  $\Phi$  is matrix of which the rows include the response of all kernel functions to input  $x_i$ :

$$(\Phi)_i = [1, \phi_1(x_i), \phi_2(x_i), \dots, \phi_n(x_i)] \quad (4)$$

Based on priori probability distribution and likelihood distribution, calculate the posterior probability distribution of model weights with Bayesian method. The formula can be written as:

$$p(\omega | t, \alpha, \sigma^2) = \frac{p(t | \omega, \sigma^2) p(\omega | \alpha)}{p(t | \alpha, \sigma^2)} \quad (5)$$

The posterior distribution of model weight is multivariate Gaussian distribution, that is:

$$p(\omega | t, \alpha, \sigma^2) = N(\mu, \Sigma) \quad (6)$$

Where:  $\Sigma = (\sigma^{-2}\Phi^T\Phi + A)^{-1}$  is covariance,  $A$  is diagonal matrix of  $(\alpha_0, \alpha_1 \dots \alpha_n)$  and  $\mu = \sigma^{-2}\sum \Phi^T t$  is mean value. The likelihood distribution of training target value can realize marginalization by integration.

Finally, the estimated value of model weights in RVM method are given by the mean value of posterior distribution, as well as it is maximum a posteriori (MAP) estimation. The MAP estimation of model weight depends on hyper-parameters  $\alpha$  and noise variance  $\sigma^2$  and its estimated value  $\bar{\alpha}$  and  $\bar{\sigma}^2$  can be obtained by maximizing the marginal likelihood distribution. The uncertainty of model weight optimal value reflected by posterior distribution may shows the uncertainty of model predictions. RVM solves the problem of parameters selection with significance under Bayesian framework which has wide applicability. Using RVM for regression prediction, we can obtain better predicted value and its variance range.

IV. COMPARISON TEST ANALYSIS

A. The original test data

The above-mentioned models have been used to predict the hourly urban water consumption in Zhengzhou city. The data used to build models are water consumption, the highest temperature, the lowest temperature and date type value from 1 January, 2015 to June 15, 2015.

B. The forecast result analysis of moving arithmetic mean

$n$  is selected as 3, and then we predict using the data from July 7 to July 9, 2015. Figure 1 gives the forecast result of moving arithmetic mean method.

As figure 1 shows, the forecast result is not good. The average absolute error is 1204.9 m<sup>3</sup>; the average absolute percentage error is 4.86%; there are absolute values of relative error of 10 periods of time above 6% and the biggest one is 11.4% among 24 periods of time.

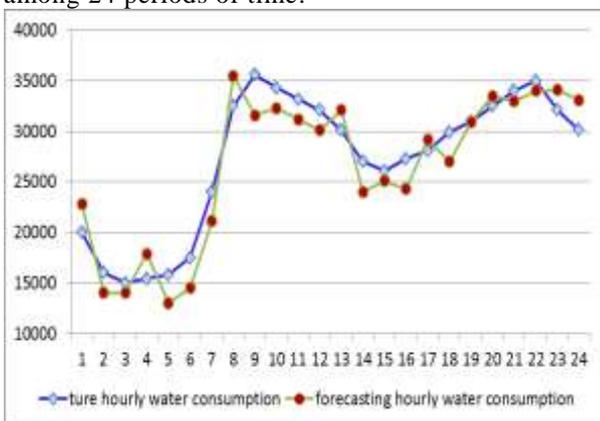


Figure 1. Forecast result with moving arithmetic mean

C. The forecast result analysis of regression model

In the regression model, one day is divided into 24 periods of time to get better results. The data, from 1 January, 2015 to June 15, 2015, have been input into the model which manages to get the coefficients. The data include former hourly water consumption, the highest temperature of the forecast day, the lowest temperature of the forecast day and the date type value.

The water consumption of July 10, 2015 has been predicted, according to the regression analysis model, using its water consumption, the highest temperature of the forecast day, the lowest temperature of the forecast day and the date type value on July 9, 2015. Figure 2 gives the hourly water consumption forecast result of the regression analysis model.

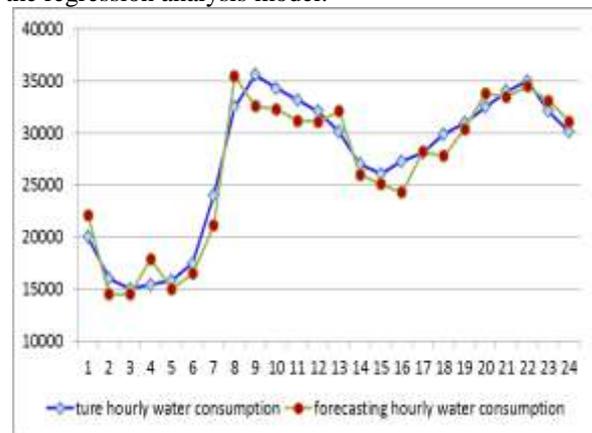


Figure 2. Forecast result with regression model

As the obtained result shows, regression analysis model is better. The average absolute percentage error is 3.56%; there are absolute values of relative error of 4 periods of time above 4.3% and the biggest one is 6.1% among 24 periods of time.

D. The forecast result analysis of RVM model

The forecast process can be summarized as the following steps [5]:

- 1) Initialize hyper-parameter  $\{\alpha_i\}$  and variance  $\sigma^2$ ;
- 2) Calculate posteriori statistic of weight  $\mu$  and  $\Sigma$ ;
- 3) Calculate all the  $y_i$  and re-estimate the  $\{\alpha_i\}$  and  $\sigma^2$ ;
- 4) If being convergent, go to step (5), otherwise go back step (2);
- 5) Delete the weights and basis function of which  $\alpha_i = \infty$ ;
- 6) Forecast new data and the mean value is  $y(x, \mu)$ .

The water consumption data are predicted, using the data such as the highest temperature of the forecast day, the lowest temperature of the forecast day, the date type value, and former water consumption of July 9, 2015. Figure 3 gives the forecast result by RVM model.

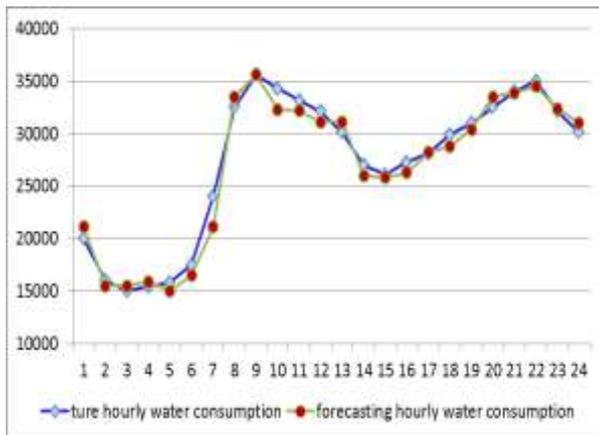


Figure 3. Forecast result with RVM model

As the obtained result shows, RVM model is much better. The average absolute error is 501.1 m<sup>3</sup>; the average absolute percentage error is 1.98%; there are absolute values of relative error of 3 periods of time above 5% and the biggest one is 4.23% among 24 periods of time.

#### V. CONCLUSION

In this paper, in order to predict the water quantity of every hour in Zhengzhou, we have presented prediction models based on RVM. In comparison with the traditional urban water consumption, that is moving arithmetic mean and regression model, RVM overcomes the shortcomings of having too many Support Vectors and eliminates the process of adjusting regularization parameter and insensitive parameters in model training. And moreover, RVM need not satisfy Mercer conditions, so kernel function has greater range of choices. We obtain the result by actual data of water supply and meteorology, and the results of the experiment suggest that the average

absolute percentage errors of these prediction models are less than 5%, and these prediction models can meet the demand of urban water supply forecast.

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# Inventory Level Control of Enterprise Supply Chain Based on Unemployment Insurance Theory

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**Abstract**—The management of enterprise supply chains affects inventory level as well as antinomy relationship between inventory and stock out. Previous studies only investigate inventory level control under the circumstances of a relatively stable economic environment. Based on Feldstein's Unemployment Insurance Theory, this paper constructs a model for the management of supply chain inventory level in changing economic environment. It analyzes the changes of supply chain inventory level in uncertain economy. The findings are as follows: in a bad economy, supply chain inventory level should be reduced if the proportion of stock out compensation paid decreases or the amount of stockout compensation increases; in a good economy, in contrast, supply chain inventory level should be raised when the proportion of stock out compensation decreases or its amount increases.

**Index Terms**—Inventory Level Control, Enterprise Supply Chain, Unemployment Insurance Theory, Stock out

## I. INTRODUCTION

Researchers and practitioners have been considering the popular topic on how to lower supply chain inventory level to the maximum extent. They expect to achieve the goal without causing stockout, or the rising of enterprise cost even if stockout happens. It is a prerequisite and ultimate goal for modern enterprise supply chain to satisfy customer needs with a minimum inventory level. Scholars propose various models or strategies for inventory level management targeting different situations. Banerjee (1986) builds up a joint economic-lot-size model aiming at the sum of inventory expenses from both Purchasers and Vendors<sup>[1]</sup>. Chen and Zheng (1997) make clear accurate results of reorder points when central warehouses adopt multi-echelon inventory<sup>[2]</sup>. Viswanathans (1998) puts forward an optimization for an integrated Vendor-Purchasers inventory model considering one vendor and one purchaser, and posits that vendors and purchasers work together to coordinate the manufacture and inventory<sup>[3]</sup>.

Since 21 century, many enterprises have introduced supply chain management as the occurrence of new enterprise management and operation model like supply chain, virtual enterprise, Flexible Manufacturing System, and researches on inventory management in supply chain has become a brand-new topic. Cachon (2001) investigates inventory competition in two-phase distribution system with multiple vendors based on game theory. The study considers the choice between competitive inventory strategy and cooperative inventory strategy in supply chain with one provider and N vendors<sup>[4]</sup>. AbdulJalbar (2003) presents a distribution system with one warehouse and n vendors on the premise of known vendor demands, ignorable lead time and forbidden stockout. Near optimal strategy under centralized inventory management and decentralized inventory management is worked out via seeking reorder points that incur minimum cost in the distribution system<sup>[5]</sup>. Anderson (2006) considers the loss of short-term order and long-term order due to stockout, and establishes a inventory model to quickly measure stockout loss based on empirical data<sup>[6]</sup>. Yang and Hua (2007) discusses dynamic lot-size inventory management model in situation of unstable demands<sup>[7]</sup>.

The above mentioned researches on supply chain are conducted from the perspective of relatively stable external economic environment, while inventory level in an unstable economic environment, economic boom or depression for instance, is rarely studied. Supply chain in good economy often receives a large amount of orders and faces stockout due to insufficient inventory. In this case, expenses paid for stockout surpass that of storage. Negative consequences like the impaired reputation of supply chain, the great loss of customers, etc. Supply chain enterprises generally possess private warehouses because of its lower expenses compared with lease warehouses. The scale of private warehouse, as well as its inventory level, is restricted because enterprises have to save operation cost, in case of waste of recourses in bad economy. Redundant inventory in bad economy can lead to bullwhip effect, including excessive inventory, fund shortage and rising cost of supply chain and other consequences.

Therefore, supply chain should figure out an optimal strategy in a changed economic environment, such as whether and when inventory is needed, when it is to be

added or lowered, the inventory level and the antinomy relationship between inventory and stockout, thus achieving the goal of minimum cost of supply chain and maximum benefits. As problems tackled by Unemployment Insurance Theory are similar to those trouble stockout in unstable economy, this paper hopes to solve inventory management in changing economic environment with the introduction of Unemployment Insurance Theory. We present a new inventory management method targeting an unstable economy based on Feldstein's theory. Its ultimate goal is to resolve problems related to inventory level management, lower overall cost of supply chain, increase its benefits and competitiveness.

## II. A BRIEF INTRODUCTION TO UNEMPLOYMENT THEORY AND ANALOGY OF INVENTORY AND STOCK OUT

Since 1970s, economists have begun to pay attention to unemployment insurance theory, based of which more ideas have been created. Black 和 Kelejian (1970) believe that unemployment tax in reality is a kind of income tax shared by enterprises and workers, causing the decrease of labor supply and demand. Besides, expenses generated by inventory and stockout are shared by enterprises and consumers<sup>[8]</sup>. Feldstein(1976)和 Baily (1977) believe that enterprises will dismiss workers in declining market and economy<sup>[9] [10]</sup>. Enterprises, in economic depression, generally prefer to lower the inventory.

Mortensen (1977) supports Feldstein's theory and points out that unemployment insurance also possesses entitlement effect which encourages people to hunt for jobs. It mainly manifests itself in the fact that unemployment insurance increases the appeal to work because many workers are not qualified for unemployment insurance<sup>[11]</sup>. Similarly, clients cannot get stockout compensation owing to providers' problems, while high stockout compensation can enhance their expectation to get it.

Topel and Welch (1980) in their research conclude that unemployment insurance has double effect. On the one hand, enterprises which rarely dismiss workers often pay more unemployment insurance than the compensation that their former employees received, thus unemployment insurance becomes burden for enterprises and impedes their aspiration to expand workforce; on the other hand, employees from enterprises which dismiss workers frequently receive much higher compensation than the sum of unemployment insurance that enterprises have paid, turning unemployment insurance into subsidies for layoff. As a result, enterprises employ a large amount of labors to expand the business in economic boom, yet in depression they will dismiss numerous employees causing the great rise of unemployment rate<sup>[12]</sup>. Inventory has similar double effect. From the perspective of enterprises that are seldom out of inventory, inventory sometimes become their burden since the cost of inventory is higher than a lower inventory level, so they expect to reduce the inventory. But for enterprises that often experience

stockout, the expenses caused by stockout generally are more than a higher inventory level. As a result, enterprises will increase their inventory to satisfy customer demand and avoid stockout in economic boom, while they will reduce inventory level and often experience stockout in depression.

Feldstein (1982) in his research finds out that more generous unemployment insurance will lead to higher unemployment compensation<sup>[13]</sup>. Similarly, higher rate of stockout indicates more stockout compensation. Hamermesh (1982) believes that unemployment insurance strengthen labors motivation to find a job since they can get unemployment insurance after losing jobs. It makes people feel better than having no job and increase participation rate in workforce<sup>[14]</sup>. Stockout can enhance enterprises' expectation to increase inventory because proper inventory level is better than zero inventory. Marimon and Zilibotti (1998) stress that employees and enterprises should match each other in accord with comparative advantage. On the one hand, unemployment insurance can improve work structure to generate more efficient work and overall output<sup>[15]</sup>. Enterprises compare inventory and stockout and ascertain the optimal inventory level, improving resources distribution and inventory management. According to the above analysis, unemployment insurance and inventory management have a bundle of intrinsic similarities in unstable economy. Therefore, it is practical and necessary to consider supply chain management in unstable economic environment based on unemployment insurance theory.

## III. SUPPLY CHAIN INVENTORY MANAGEMENT OF NEW ENTERPRISES BASED ON UNEMPLOYMENT THEORY

As the development of globalization, competitions among supply chain become more and more fierce. Enterprises pay more attention to inventory management for the purpose of cost-saving and competitiveness enhancing. Some enterprises even advocate zero inventory. Nevertheless, inventory level of certain enterprises remains high. However, as some enterprises reduce their inventory greatly to lower overall cost, stockout happens for the lack of inventory. This leads to the inefficiency of supply chain, the rise of overall cost and the loss of customers. Therefore, this paper proposes a new inventory level management approach in uncertain economic environment based on Feldstein's unemployment insurance theory. We hope that enterprises can adopt this approach to resolve inventory management problems and enhance the competitiveness of supply chain.

Enterprise supply chain management can be divided into different types according to various criteria. Different types indicate differences in model structure and algorithm. We need to make the following illustration beforehand so as to discuss supply chain inventory level management:

H1: suppose inventory earning of one enterprise supply chain be  $AF(I)$ ;

- H2:  $I$  is short for model inventory named “Inventory”;
- H3:  $A$  has two probable values:  $A = A_B$  in bad economy, while in good economy  $A = A_G$  and  $A_G > A_B$ ;
- H4: suppose the time for  $A_B$  and  $A_G$  is equal.
- H5: if  $A = A_G$ , supply chain has inventory;
- H6: if  $A = A_B$ , stockout happens in supply chain and stockout compensation  $B > 0$  needs to be paid.
- H7: suppose inventory risk is neutral.
- H8:  $\omega$  is inventory expense;
- H9:  $K$  is disutility of inventory and  $I_B$  and  $I_G$  are inventory level in the two situations;
- H10:  $c$  is the proportion of compensation paid by supply chain in overall stockout compensation, and suppose  $0 \leq c \leq 1$ ;
- H11:  $u_0$  represents expected utility.

Hence, the amount of model inventory is:

$$U = \frac{(w-K)}{2} + \left[ \frac{I_B}{2I_G}(w-K) + \frac{I_G - I_B}{2I_G} B \right]$$

Expected profit is:

$$\pi = \frac{A_G F(I_G) - wI_G + A_B F(I_B) - wI_B - cB(I_G - I_B)}{2}$$

If expected utility of inventory is  $u_0$ , the equation for the maximization of expected profit is:

$$\begin{aligned} \max 2E(\pi) &= A_G F(I_G) - wI_G + A_B F(I_B) - wI_B - cB(I_G - I_B) \\ \text{s.t.} (w-K) + \frac{I_B}{I_G}(w-K) + \frac{(I_G - I_B)B}{I_G} &= 2u_0 \end{aligned}$$

Lagrangian Function is:

$$L = A_G F(I_G) - wI_G + A_B F(I_B) - wI_B - cB(I_G - I_B) + \lambda \left[ (w-K) + \frac{I_B}{I_G}(w-K) + \frac{(I_G - I_B)B}{I_G} - 2u_0 \right] \tag{1}$$

**Definition 2.1** For Function  $F(\bullet)$ , if there exists  $\forall x, y$  and  $\alpha \in [0, 1]$  enabling  $F(\alpha x + (1 - \alpha)y) \geq \alpha F(x) + (1 - \alpha)F(y)$ , we say  $F(\bullet)$  is concave.

**Theorem 2.1** If concave function  $F(\bullet)$  is doubly differentiable, then  $F''(\bullet) \leq 0$ .

Proof

Let  $x = z - \delta$ ,  $y = z + \delta$  and  $\alpha = \frac{1}{2}$ , then  $F$  is concave

indicates:

$$F(z) \geq \frac{1}{2} [F(z - \delta) + F(z + \delta)]$$

$$\text{or } 0 \geq \frac{\frac{1}{2} \{ [F(z + \delta) - F(z)] - [F(z) - F(z - \delta)] \}}{\delta^2}$$

If  $F(\bullet)$  is differentiable, limit  $\delta \rightarrow 0$  can be obtained from the above inequation and then we get  $F''(\bullet) \leq 0$  Q.E.D.

According to definition 2.1, in equation (1)  $F(\bullet)$  is correct if  $\alpha = 0$  or  $\lambda = 1$ :

$$F(\alpha x + (1 - \alpha)y) \geq \alpha F(x) + (1 - \alpha)F(y)$$

Hence, in equation (1)  $F(\bullet)$  is concave. Since  $F(\bullet)$  is differentiable,  $F''(\bullet) \leq 0$ .

First order partial derivative of equation (1) is calculated and let it equals zero, equation (2), (3), (4) are as follows:

$$\frac{\partial L}{\partial w} = -I_G - I_B + \lambda + \lambda \frac{I_B}{I_G} = 0 \tag{2}$$

$$\frac{\partial L}{\partial I_B} = A_B F'(I_B) - w + cB + \lambda I_G (w - K) - \frac{\lambda B}{I_G} = 0 \tag{3}$$

$$\frac{\partial L}{\partial I_G} = A_G F'(I_G) - w - cB - \frac{\lambda I_B}{I_G^2} (w - K) + \frac{\lambda B I_B}{I_G^2} = 0 \tag{4}$$

$\lambda$  is worked out in equation (2):

$$\lambda \frac{I_G + I_B}{I_G} = I_G + I_B$$

Simplified as:

$$\lambda = I_G \tag{5}$$

Substitute equation (3) with equation (5):

$$A_B F'(I_B) - w + cB + (w - K) - B = 0$$

Simplified as:

$$A_B F'(I_B) - K - B(1 - c) = 0 \tag{6}$$

Calculate the derivative of  $c$  on both sides of equation (6):

$$A_B F''(I_B) \frac{\partial I_B}{\partial c} + B = 0 \tag{7}$$

Since  $B > 0, A_B > 0$  and  $F''(\bullet) \leq 0$ ,  $\frac{\partial I_B}{\partial c}$  is calculated in equation (7):

$$\frac{\partial I_B}{\partial c} = -\frac{B}{A_B F''(I_B)} > 0 \tag{8}$$

Therefore, enterprise supply chain will reduce its inventory if proportion of stockout compensation paid fall down in bad economy.

Similarly, calculate the derivative of  $B$  on both sides of equation (6):

$$A_B F''(I_B) \frac{\partial I_B}{\partial B} - (1 - c) = 0 \tag{9}$$

If only  $c < 1$ , since  $F''(\bullet) \leq 0$ ,  $\frac{\partial I_B}{\partial B}$  is calculated in equation (9):

$$\frac{\partial I_B}{\partial B} = \frac{1-c}{A_B F''(I_B)} < 0 \quad (10)$$

Hence, if only  $c < 1$ , since  $F''(\bullet) \leq 0$ , enterprise supply chain will reduce its inventory if the amount of stockout compensation B rises in bad economy.

Substitute equation (4) with equation (5):

$$A_G F'(I_G) - w - cB - (I_B - I_G)(w - K) + \frac{I_B}{I_G} B = 0$$

Simplified as:

$$A_G F'(I_G) - w - cB - \frac{I_B}{I_G}(w - K - B) = 0 \quad (11)$$

Change equation (11) into:

$$A_G F'(I_G) - cB = w + \frac{I_B}{I_G}(w - K - B) \quad (12)$$

Multiply 2 on both sides of expected effect:

$$w - K + \frac{I_B}{I_G}(w - K) + \frac{I_G - I_B}{I_G} B = 2u_0 \quad (13)$$

Change equation (13):

$$w + \frac{I_B}{I_G}(w - K - B) = 2u_0 + K - B \quad (14)$$

Equation (12) and (14) are equal:

$$A_G F'(I_G) - cB = 2u_0 + K - B \quad (15)$$

Simplify as:

$$A_G F'(I_G) = (2u_0 + K) - (1-c)B \quad (16)$$

Calculate the derivative of c on both sides of equation (16):

$$A_G F'(I_G) = (2u_0 + K) - (1-c)B \quad (17)$$

Since  $B > 0, A_G > 0$  and  $F''(\bullet) \leq 0$ ,  $\frac{\partial I_G}{\partial c}$  is calculated in equation (17):

$$\frac{\partial I_G}{\partial c} = \frac{B}{A_G F''(I_G)} < 0 \quad (18)$$

Hence, enterprise supply chain will increase its inventory if proportion of stockout compensation paid decreases in good economy.

Calculate the derivative of B on both sides of equation (16):

$$A_G F''(I_G) \frac{\partial I_G}{\partial B} = -(1-c) \quad (19)$$

If only  $c < 1$ ,  $F''(\bullet) \leq 0$ ,  $\frac{\partial I_G}{\partial B}$  is calculated in equation (19):

$$\frac{\partial I_G}{\partial B} = -\frac{1-c}{A_G F''(I_G)} > 0 \quad (20)$$

Hence, if only  $c < 1$ ,  $F''(\bullet) \leq 0$ , enterprise supply chain will increase its inventory if the amount of stockout compensation rise in good economy.

#### IV. CONCLUSION

It is of great significance for managers to control supply chain because it influences not only inventory level of supply chain and also relationship between inventory and stockout. Managers often face dilemma caused by high inventory level, namely high cost of supply chain and low level of inventory which together result in stockout. The influence of this dilemma on supply chain cost and profits is enhanced in uncertain economic environment. Therefore, enterprise supply chain managers should strictly control inventory level after analyzing internal and external environment of supply chain to avoid unnecessary loss generated by too high or low inventory.

This paper consider influences of changing economic environment on supply chain inventory level through investigating antinomy relationship between inventory and stockout. According to Feldstein's unemployment insurance theory, this paper analyzes whether enterprise supply chain inventory level should be increased or decreased in uncertain economic environment. The findings are as follows: first, the reduction of proportion of compensation paid by enterprise will lead to the slash on supply chain inventory level in bad economy; Second, the rise of the amount of compensation caused by stockout will impel enterprises to lower its inventory in bad economy; Third, the decrease of the proportion of stockout compensation will encourage enterprise to raise its inventory in good economy; finally, the rise of stockout compensation will lead to the increase of inventory level.

The paper finds out that the results are greatly in accordance with applied researches on enterprise supply chain management at home and abroad. On the one hand, enterprise supply chain should lower its inventory level in bad economy, otherwise bullwhip effect resulted from high inventory level can increase harmful consequences like the rise of supply chain cost; on the other hand, supply chain can increase its inventory level in good economy, or bring about undesired results due to inventory out including the rise of supply chain cost and the loss of customers.

Accurate value of increasing or decreasing inventory level in uncertain economy can be calculated based on models presented in references [1-7], or other models available. In the current paper, we will not further the study for the sake of paper length.

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# Research on the Opening of Sports Facilities to the Public in Chinese Urban Schools

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**Abstract**—The public sports facilities are considered as the important factors which can influence and restrict the masses to participate in the sports activities. Currently, there is a serious lack of public sports facilities in China, and a large gap of sports venues area per capita exists between China and other developed countries in the world. However, the opening of school sports facilities to the public can relieve the lack of sports facilities in China. By means of document research, questionnaire, comparative analysis and mathematical statistics, the author makes an analysis on the serious lack of public sports facilities in China and the current condition of the relatively advanced school sports facilities in the paper which can further promote Chinese National Fitness Program and Sunshine Sports project and provide a new perspective for the opening of school sports facilities to the public in China.

**Index Terms**—Urban schools, sports facilities, research on opening to the public

## I. INTRODUCTION

Currently, in many cities, on one hand, residents in community do not have enough fitness places. Many studies have pointed out that one of the main obstacles to the development of mass sports in China is the serious shortage of sports facilities.

July 2002, Opinions on Strengthening and Improving Sports Activities in the New Era by CPC Central Committee and the State Council pointed out, "Sports facilities in schools, institutions, enterprises and institutions should achieve social sharing". This shows that the implementation of the school sports to the public with certain obligation, but the actual situation is not optimistic. Indeed, the fact that school sports facilities open to the society will face some problems, but as long as the policy is reasonable, it can meet the needs of students and society, and also is conducive to the development of school sports and social sports. In the case of normal school teaching, the reform for school sports facilities should be attempted to explore actively.

## II. RESEARCH OBJECTS AND METHODS

### (1) To find documents and literature

Through literature, documents, the Internet and CNKI database, researchers should search the development,

resource allocation, resource sharing and other aspects of sports facilities in urban schools.

### (2) To do questionnaire survey

Researchers should do questionnaire with the famous domestic sports experts, school sports experts, sports management experts, and personnel of school sports facilities, leaders in teaching and research groups, physical education teachers, and students.

### (3) To do interview

Researchers should do interview with experts who engage in school sports, sports management and research as well as the experts who engage in school sports facilities, leaders of sports teaching and research, physical education teachers, and even students, and managers of community sports facilities. Those interviews include group discussions, telephone inquiry, e-mail, and others. Through various channels, people can solicit and record the views on the research and then straighten up, in addition, some ordinary residents should be involved in the interview. Those views can provide solid and rich examples for the research.

### (4) Mathematical statistics

To collect data from the above three methods, researchers can use mathematical statistics method to make an analysis, providing quantitative reference basis, then people can make a deep and comprehensive study by qualitative analysis and quantitative analysis.

## III. RESEARCH RESULTS AND ANALYSIS

### A. Analysis on status quo of sports facilities in China

#### (1) The status quo of sports facilities in China

By December 31, 2013, according to the requirements of the sixth national sports venues survey, there were 984,160 sports venues in China (including the national scope, except Taiwan, Hongkong, Macao), including 633,482 standard sports venues, 350,678 non-standard sports venues, covering an area of 2,610,000,000 square meters, construction area is 87,144,000 square meters and 1,540,000,000 square meters is the area for sports venues. In the census of the 984,160 sports venues, there are 64 types of standard sports venues. Among them, the number of stadium, gymnasium, swimming pool, diving hall and other large stadiums is around 6340, accounting for 1% of the total number of standard sports venues, accounting for 0.64% of the total number of national

sports venues; the number of indoor swimming pool, gymnasium and basketball hall and other indoor sports venues is about 64,460, accounting for 10.1% of the total number of standard sports venues, accounting for 6.5% of the total number of national sports venues; the number of outdoor swimming pool, outdoor tennis courts and football fields and other outdoor sports venues is 562,444, accounting for 88.8% of the total number of standard sports venues, accounting for 57.1% of the total number of national sports venues. In outdoor sports venues, the number of basketball courts, small sports games and volleyball courts is 505,090, accounting for 79.7% of the total number of standard sports venues. In the current 984,160 sports venues in China, the number of sports venues and the proportion of each system are shown in table 1.

TABLE 1. Number and proportion of sports venues in various systems in China

Sports system	Education system	Xinjiang Production and Construction Corps	PLA system	The armed forces system	Railway system	Other systems	Total
21652	645609	3937	7873	14762	16731	273596	984160
2.2	65.6	0.4	0.8	1.5	1.7	27.8	100 (%)

From table 1, people can see that the type and quantity of sports facilities in China is not balanced. This is bound to affect the development of mass sports in China.

(2) The status quo of school sports facilities in China

According to the report of the sixth national sports field survey, among China's existing 984,160 sports venues, 21,652 venues are in sports system, accounting for 2.2% of the total number of sports venues; 645,609 in education system, accounting for 65.6% of the total number of sports venues, and the number and proportion of school sports venues in the education system are shown in table 2. In China, implementation of the opening of the school sports venues to the public is in the primary stage. in 1995, the former State Sports Commission announced Report on the Opening of School Sports venues to the public, then some of the schools began to open to the public. According to the 2001 national soft science research project Research on the Opening of College, Middle and Primary School Sports Venues to the Community, the current rate of the opening to the public in the university is 64.2%, the rate in middle schools is 59.1%, the rate in primary schools is 27.1%. In recent years, China has introduced a series of policies and measures to improve the opening rate of sports venues. Although it is very effective, it is still not satisfactory to the public, especially, the majority of sports venues belong to education system, accounting for 65.6% of the total. But, at present, the opening rate of Chinese school sports venues is only 29.2%, while the utilization rate is not high, which makes China's current limited resources can not be fully utilized, resulting in man-made waste. Although the number of sports venues in China has reached 984,160, but the proportion of public sports venues is relatively small, and the scale is relatively small,

the average size of each 100,000 people with open stadium is only 25.9, which is far from meeting the needs of the masses fitness activities.

However, a large number of the school sports facilities lie around. The time of using the school sports facilities every day (for students in school) is about 7 hours, and in 85% of the vacations and holidays, they are closed, so the time for using is less than 200 days, and the utilization rate is very low. China has about 540,000 primary and secondary schools, about 300,000,000 square meters of sports venues (excluding indoor fitness venues). In the recent two years, the administrative departments of sports and education have taken active measures to open school sports facilities, and have achieved initial results. But at present, the situation of the opening of school sports facilities to the public in some areas of the country is not satisfactory.

TABLE 1I. Number and proportion of sports venues in various systems in China

Colleges and universities	Vocational and technical schools	Middle school and Primary Schools	Total
44547	21951	579111	645609
6.9	3.4	89.7	100%
Colleges and universities	Vocational and technical schools	Middle school and Primary Schools	Total
44547	21951	579111	645609
6.9	3.4	89.7	100%

(3) The status quo of sports facilities for the public in China

Because of the distribution of sports venues, the places really be used for mass sports fitness are quite less. It shows from the survey that 63.5% of the sub-district offices have no sports facilities in 8 areas around Beijing city, and the rest 36.5% only have table tennis room, chess room, gate ball court and other small venues. The public sports venues in Guangzhou are around 1,150,000 square meters, less than 200 square meters per 1000 people, which is far from the national average of 300 square meters per thousand people. And the lack of community sports venues and facilities is also reflected in varying degrees in Shanghai, Tianjin, Ji'nan, Hangzhou, Nanjing and other large and medium cities.

In China, 97% of the sports venues belong to the various departments and systems. 21% of the school population occupies 66.7% of the sports venues. In 1996, it is found in the survey that, in all the sports venues, the public sports venues and sports facilities in China only accounted for 2.3% of the total national sports venues and the opening of the sports venues to the public is different in various systems. So, the real place for mass sports and physical exercise is only 10% of the total national sports venues and facilities. Only 23.2% of people doing physical exercise in China are in the sports venues, and 37.3% of people are in the road, square or other open space.

TABLE III. SURVEY ON PLACES FOR DOING PHYSICAL EXERCISE

Location	Rate (%)	Location	Rate (%)
Space near home	34.3	Road	13.0
Park	24.0	Sports stadium	10.1
Work unit	15.8	Place for entertainment	2.8

As can be seen from table 3, people in the streets or parks account for 37.0% of the total number, because there is no sports venues for them to do exercise. While running along the road, vital capacity can be increased; people will inhale more dust and vehicle exhaust, which virtually increases the damage to the body. Because of the lack of sports facilities and venues nearby, people are forced to make the choice, it can be seen that the sports facilities venues for the mass are in serious shortage.

#### *B. The necessity of opening up the school sports facilities to the public*

(1) The advantages of school sports facilities are in favor of the extensive development of the national physical fitness

The advantages of school sports facilities can make full use of the existing school facilities, venues and resources to provide material basis for the development of the national fitness campaign. From the current economic situation in China, it is not allowed to build a large number of community sports facilities. To make use of school venues in the spare time will be able to solve the problem of lacking sports venues for the community residents to do exercise, which provides a strong guarantee for the further development of national fitness movement and plays a positive role in the development.

(2) To fully develop and utilize school sports facilities is the full embodiment of the times

Under the traditional system, the management mode of school sports facilities is a closed operation. With the establishment of the socialist market economy system and the improvement of people's living standards, people's needs for sports fitness are growing. The traditional management mode has become increasingly unable to meet the needs of the development of the situation. In the premise of ensuring the use of the school, the opening of school sports facilities to the public is the current international practice. How to break the traditional management idea, and make full use of the school sports facilities, from the closed operation to the open-up, is the new topic for the government functions under the new situation.

(3) To solve the problem of lacking social sports instructors in China

Another prominent problem in current development of mass sports in China is the lack of knowledgeable sports instructors. In Analysis on Influence Factors of People in Pearl River Delta Participating in Physical Exercise by Liu Jiangnan, Xu Yonggang in Guangzhou Sports University, the factors "no venues" and "no instructors" occupy a considerable proportion of all the factors. School physical education teachers and students who are good at doing sports (in Universities), have a solid technical skills, rich sports theory and plenty of physical fitness, so, in the condition of the completion of their own

work, they can be fully engaged in the guidance of the masses and activities. The opening of school sports facilities can not only ease the lack of public sports venues, but also make up for the lack of social sports instructors, which are a suitable place for teachers and students to display their talent.

(4) The strong demand of people on the opening of the school sports facilities

The opening of school sports facilities can bring many benefits to people's health. First of all, schools mostly lie in the community, so it is good for the surrounding residents to do morning and evening exercise or holiday fitness. Second, it can reduce the economic burden for the residents. In the current situation, if there is no suitable place for fitness, residents will be forced to give up the need to do exercise or pay for the special fitness places. For the ordinary, the spending can increase the economic burden. Therefore, the school is their best choice, and they have a strong desire to go to school. They hope the school can open the door and meet their needs.

#### *C. Constraints for the opening of school sports facilities*

(1) Consciousness concept

The obligation and importance for the opening of school sports venues and facilities are not gained correct understanding. Many primary and middle schools have been in the closed management for a long time, which result in unenthusiastic attitude of the schools on the opening of school sports venues and facilities.

(2) Conditions on opening

Some schools are small with simple sports facilities, and the layout of the school is not reasonable, for example, the activity area and the teaching area is mixed with no obvious division, so it will increase the difficulty of management. Opening space is greatly affected. Some boarding schools have students 24 hours a day at school, so the opening time is also constrained.

(3) Funding without guarantee

Opening to the outside will increase the cost of sports facilities maintenance, renewal and management. However, based on serving people, schools can get low charge or no charge, so they can not get a balance between the income and the cost. Thus, the expenditure is much more than the income.

(4) Security risks

As shown in the survey, the security problem is the primary reason for many schools who are doubt about the opening, accounting for 56.9% of respondents. The reasons are shown as follows, first, areas for teaching and areas for sports are mixed together in many schools; second, the issue of security and order. People from the society are different from students. Some may damage the school facilities, property, green environment, even bring drug to the campus or deliberately cause trouble. At the same time, the vehicle into the campus also brings traffic management problems; third, the responsibility of the safety accident. Due to the opening, especially with appropriate charge, the responsibility of the security incident is a problem for school to concern, which should be determined by laws and regulations but fail to get effective support of the policy.

#### D. Suggestions on promoting the opening of school sports facilities

(1) To improve the awareness of the importance of school sports facilities

In order to better implement the decision of the CPC Central Committee on Deepening Education Reform and Promoting the Quality Education, the implementation of National Fitness Program and the all-round development of teenagers should be combined together, people must further enhance awareness of the importance of the opening of school sports facilities, which can not only enhance people's physical quality, but also has the significance of improving the overall quality of the whole nation.

(2) Adhere to the principle of reasonable fees and paid services

The management of sports facilities can refer to Notice on Sports Market Management on May 9, 1994 and Notice on Further Strengthening the Management of Sports Market on July 1, 1996 issued by the State General Administration of Sports, which are the basic management policy for the opening of school sports venues and facilities. Schools can gain certain charge from the opening, and the charge is mainly used for the maintenance of sports facilities, purchasing new sports equipment and cost of water, electricity, space management and labor. The formulation of the charging standard must take into account the geographical position, the economic situation of the local area, and the economic capacity of the public. 20% can be extracted from the total charge as fixed costs for equipment maintenance and acquisition, which can basically solve the financial problem of facilities maintenance and renewal.

(3) Under the premise of ensuring the teaching and training

The main function of the school sports facilities is for the school's teaching and training, so the school's normal teaching and training should be firstly ensured, then the school sports facilities can be open to the public. The opening for economic benefits should not affect normal teaching and training activities. The time of opening should also adapt to the residents' rest time.

#### IV. CONCLUSIONS AND RECOMMENDATIONS

The total amount of sports venues and facilities in China is insufficient, the opening progress of school

sports facilities is slow, and the mass sports facilities need to be improved.

The necessity of opening the school sports facilities to the public is shown as follows.

(1) be conducive to the development of national fitness;

(2) the trend of harmonious development of school and society;

(3) to alleviate the shortage of social sports instructors.

The opening faces the following problems:

(1) opening-up awareness of schools;

(2) the required hardware conditions for the opening;

(3) the required software such as management;

(4) security issues.

Despite the serious shortage of public sports facilities in China and a clear gap between the developed countries, the opening of school sports venues and facilities to the public is at a run with the national related policy and the consciousness enhancement of national fitness. A national fitness climax is coming, and the physical quality of the whole nation will have a great leap.

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# Analysis of the Causes of China from the Perspective of Regional Unbalanced Economic Development

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**Abstract**—With the rapid development of economy, people's living standards continue to improve. China has vast territory and people are widely distributed, because of the influence of such factors as natural environment, geographical position among the regions, economic development imbalance has become a problem that can not be ignored. Unbalanced regional economic development, which has been a serious threat to the development of China's ongoing economic stability, even affected the political problem. Based on this background, using 2014 east Midwest three regions in total spending on education, science and technology spending, investment in fixed assets, and per capita consumption spending four aspects of the data, multiple linear regression, to explore the factors influencing the imbalance of regional economic development in China, and Suggestions are proposed accordingly.

**Index Terms**—Regional economy, The integration of urban and rural areas, Multiple linear regression model

## I. INTRODUCTION

As a result of China's reform and opening up, the development of economic is sustained and rapid and people's living standard is increasing day by day, but the unbalanced development of regional economy has increasingly become a problem which cannot be ignored. Unbalanced development of regional economy makes more capital and technology invested in eastern coastal areas, making its already prosperous economy get high speed development, the eastern coastal areas become worthy of the name of China's economic development motive force, and notably with the contrast, because of the input of technology, capital and talent does not reach the designated position, the western region, especially in the western rural areas, The economic development is very backward, the gap between eastern areas and western is becoming more and more wide, The regional economic are developed into a more unbalanced direction, the political and economic problems become the focus of the government accordingly.

At present, the academic research for regional development is mainly divided into two aspects, on the

one hand is the study of a regional development strategy, such as Wenxian Jiang's evaluation of the effect on the coordinated development of regional economy in Guangdong province[1]; Wenjiong Gu, Xiangsheng An and Shangyi Wang's research on relationship between the population distribution in Shanxi Province and regional economic coordinated development[2].

On the other hand is the study of national level. Yejiang Wang and Houkai Wei focused on promoting the construction development of priority zones in the future, adhere to the innovation and informatization of regional development and improve compensation policy in the region and gradually reduce the regional disparity in order to realize the regional harmonious development[3]. Yanan Sun said the negative correlation between regional space of the economic development is the main cause of regional economic gap in China[8]. Chenlin Tan made a research to find that the level of China's regional economy coordinated development was significantly increased and the trends and characteristics of regional economic coordinated development showed obvious diversity[9].

This article adopt four variables which are education spending, science and technology spending, total fixed asset investment and Personal consumption expenditure and attempts to take a quantitative approach, using SPSS for statistical tests and linear regression to research the formation of the regional gap and put some suggestions accordingly.

## II. THE STATUS QUO OF CHINA'S REGIONAL ECONOMIC DEVELOPMENT

### A. Index selection

This article selects the average, variation coefficient and the extremum ratios to analysis the differences in the spending of education and technology (\$one hundred million) , the total amount of investment in fixed assets(\$one hundred million) and the per capita consumption spending(yuan) among the east ,the Mid and

the west in our country in 2014. By the calculation, the following is available:

Figure 1-3 analysis shows that the eastern region is higher than the Mid and west areas in the spending of education, science and technology as well as the investment in fixed assets and the average per capita consumption spending, especially the west minimum; The Mid area's coefficient of variation is the highest on the whole among the four indicators, The eastern does not change much, fluctuating around 2; In the western region, the extreme value of every index is the highest on the whole, extreme value of the total amount of investment in fixed assets is more than 20, which indicates that internal imbalance development of economy in the western region.

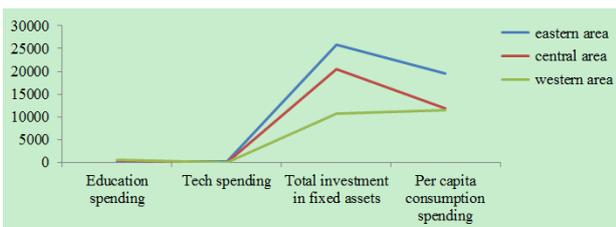


Figure 1. The line chart of each index's variation coefficient in three regions.

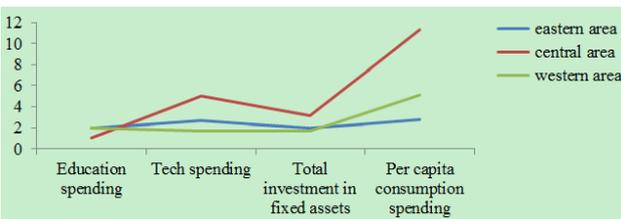


Figure 2. The line chart of each index's variation coefficient in three regions.

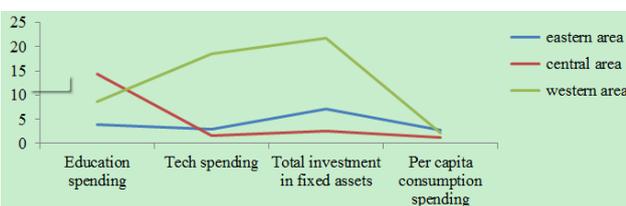


Figure 3. The line chart of each index's extreme value in three regions.

**B. Description of the status quo**

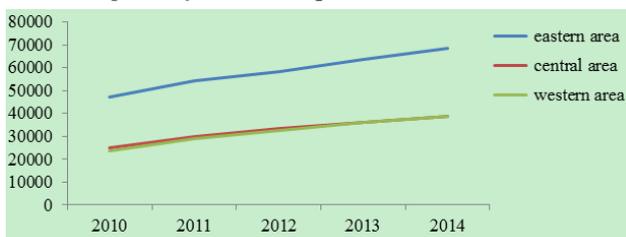


Figure 4. 2010-2014 China's per capita GDP in three areas.

From figure 4 you can see, from 2010 to 2014, regional per capita GDP increased year by year, the per capita GDP of eastern region is far higher than the Mid and west, and it's developed at a rapid pace. The per capita GDP gap between Mid and West gradually narrowed, per capita GDP is on the rise, but compared with the eastern region, there is still a larger development space, the trend of regional economic development level is moderate, but the overall gap remains wide.

**III EMPIRICAL ANALYSIS**

**A. The analysis of the formation elements of area gap by SPSS**

Consumption, investment, import and export are the three big carriage driving economic growth, this paper selected per capita consumer spending and investment in fixed assets as the research variables and introduced the education expenditure, and science and technology to do further analysis about the four variables' impact on regional economic development.

Compare the differences in education spending, technology spending, investment in fixed assets and per capita consumption expenditure in three different areas. Before the comparison, determine whether the data take normal distribution, using the SPSS to do a normal inspection for the data. The case  $n = 23 < 2000$ , so choose Shapiro - Wilk statistics, results show that the sig. 0.035, 0.044, 0.104 and 0.00, respectively, thus the education expenditure, technology spending, investment in fixed assets, and per capita consumption expenditure approximately obey the normal distribution under the significance level of 0.1 (although it may not be the case).

In SPSS GLM module, education spending, science and technology spending, total fixed asset investment and consumer spending per capita are selected as dependent variables for a multi-variable inspection. Output sig. 0.003, 0.000, 0.000, 0.000, no matter from which statistics, the difference of three areas (from spending on education, science and technology spending, per capita consumption expenditure, total investment in fixed assets of the four indicators of the whole) is significant on the whole

Do the effect inspection of the main subject using the datas from the three regions, sig. 0.064, 0.000, 0.010 and 0.003, respectively, show the eastern, central and western three areas are significant different in the expenditure on education, science and technology spending, total investment in fixed assets and per capita consumption expenditure on these three indicators.

**B. The credibility of the test result**

Table1 is the results of comparison for each indicator in three areas, is a measure of multiple comparison credibility, Sig value was 0.064, 0.000, 0.010 and 0.064, respectively, which is credible in the case of a given significance level of 0.05.

TABLE 1 UNIVARIATED TEST RESULTS

Source	Dependent Variable	Sum of Squares	Df	Mean Square	F	Sig.
	Education spending	419719.193	2	209859.596	3.156	0.064
	Tech spending	22728.572	2	11364.286	13.689	0
Contrast	Total investment in fixed assets	9.90E+08	2	4.95E+08	5.825	0.01
	Per capita consumption spending	2.82E+08	2	1.41E+08	7.793	0.003
	Education spending	1330048.946	20	66502.447		
	Tech spending	16604.13	20	830.207		
Error	Total investment in fixed assets	1.70E+09	20	8.50E+07		
	Per capita consumption spending	3.62E+08	20	1.81E+07		

### C. Regression model

By the comparative analysis in technology spending, education expenditure, total fixed asset investment and consumer spending per capita among the three areas, we draw a conclusion that the four indicators are significant different in three areas, and analyze the differences mainly come from which areas, namely the economic development of different regions. Next, we will introduce the variable region gross domestic product, so that we can analyze the linear relationship among technology spending, education expenditure, total fixed asset investment, per capita consumption spending and GDP and discuss the influence on the three regional economic development (represented by GDP) that the four indexes brings.

GDP in each area as the dependent variable, science and technology expenditure, education expenditure, total investment in fixed assets, and the per capita consumption expenditure as independent variable for multiple linear regression, regression coefficients of T test results show that the total amount of investment in fixed assets and the per capita consumption expenditure of fitting regression has remarkable effect on GDP and spending of science and technology and education spending does not have significant impact on GDP, which can get the regression equation for  $y = 12359.146 + 0.1264X_3 + 0.797X_4$ . The  $b_1 = 1.264$  shows that in the case of other conditions unchanged, when total investment in fixed assets increase one hundred million yuan, GDP will increase 1.264 millions;  $b_2 = 0.797$  shows that in the case of other conditions unchanged, when per capita consumption spending increase one yuan, gross regional investment will increase 0.797 yuan.

According to the results of the model summary, the determination coefficient of the regression model is 0.973, adjusted determination coefficient is 0.967, shows that the regression equation explained 96.7% of the dependent variable, goodness of fit of the equation is good. Variance analysis results shows that F test P value is 0.00, which indicates the linear relationship is significant on the whole.

### D. Heteroscedasticity test

Because of the economic phenomenon is complicated, we can't guarantee the linear regression model must have six basic hypothesis of linear regression, so in the actual economic phenomenon, heteroscedasticity problems are abound. So-called heteroscedasticity is random error variance is not constant, namely the observed values are different from each other when the interpretation variables are different. When the linear regression model's error term is heteroscedasticity, the least squares estimator of the parameter estimator is not a valid, at the same time, the OLS estimation type no longer has the minimum variance, but exaggerate the statistical significance of estimated parameters, using t test to determine the influence of explanatory variables significant will lose its significance. And the existence of heteroscedasticity will make the parameter estimation variance underestimates the true variance which may cause the distortions in the interval estimation of the parameters and affect the prediction interval of the y, reducing the prediction precision. So it is necessary for us to test the regression model for heteroscedasticity and correct it, take  $\alpha = 0.05$  as significant level, the output of White test results show that the p value is 0.2311. Which is greater than 0.05, so accept the null hypothesis, that there is no heteroscedasticity in the regression model.

## IV CONCLUSIONS AND RECOMMENDATIONS

This paper use the data in total spending on education, science and technology spending, investment in fixed assets and the per capita consumption expenditure in eastern region, mid region and west areas in the year of 2014, as well as the mean of the data, the coefficient of variation and the ratio of extreme value index, through multiple linear regression, carried on the quantitative analysis of the causes of regional gap and get the following conclusions:

(1) The economic gap between eastern region, central and western regions are wide. The respective GDP of central region and western region in 2014 were less than the

GDP of the eastern region in 2010, the region's GDP in east areas was totaled 15.25801 trillion yuan in 2010 which was the sum of the gross in the central and western regions approximately. The implementation of the eastern inclination strategy made the state investment center shift from the central western regions to eastern coastal, which changed the key construction development pattern of the central and western areas and reconstructed the peripheral zone of China's economic development.

(2) The phenomenon of unbalanced development is not only reflected among the three regions, it's also exists in the internal of western region. According to the extreme value of the total expenditure on education, science and technology spending, investment in fixed assets and per capita consumption spending in western area, only the per capita consumption expenditure's extremum ratio is 2.22 which is less than 3 (appointed 3 as a reasonable level), the rest are all greater than 3, the extreme value of the total amount of investment in fixed assets is more than 21.81, which is visible that the level of economic development is jagged between cities and small towns. The west part of China has the most wide area, the most fragile ecological environment, relatively backward of economic development, unbalanced development between urban and rural areas the most significant areas at the same time.

(3) The total fixed asset investment and per capita consumption spending are the most important in factors that influence the regional economic development and the total investment in fixed assets is the core. According to Linear equation of regression ,we can see that  $y = 12359.146 + 1.264 X_3 + 0.797 X_4$ , which shows ,in the case of other conditions unchanged, when total investment in fixed assets increase one hundred million yuan ,the regional GDP will increase 1.264 million yuan ,and when per capita consumption expenditure add one yuan, the regional GDP will increase 0.797 yuan at a time. By the regression coefficient, the change of the total amount of investment in fixed assets bring the biggest economic consequences.

In the light of the above conclusions, the methods that used to narrow the difference of regional economy are as follows:

(1) Take measures to promote the integration of urban and rural development. There are many significant differences between eastern and western areas in many aspects. To solve the problem, we should adhere to the implementation of the strategy of "urban-rural integration", the development of the villages and towns non-public enterprises, absorbing rural surplus labor, opening new channels of farmers' income, adhere to the "led the country to the city", driving the development of rural to urban development.

(2) Promote the balanced development of regional internal economy. Speeding up urbanization in the west and pay special attention to the central city of Chongqing, xi 'an, Urumqi and other functional construction, change the city non-isolating development model, " point with surface, point axis combined with", cultivate and

construct a batch of powerful leading cities and towns intensively ,which could promote the development of other cities based on the development of regional central cities. Give Play to the industrial advantage of each city, and form a situation of coordinated development .

(3) Promote the elements flowing and realize the interregional coordinated development. The eastern area of China has advanced science and technology and management experience, there is a large number of idle labor and land in the western region . All of the three areas ought to improve the high flow ability of elements and goods on the base of comparative advantage, so as to improve the efficiency of resource configuration and make the advantages of the regional integrate into the overall advantage. In the future ,we should strengthen coordination and cooperation among interregional subjects based on the urban agglomeration ,and establish a long-term mechanism for regional cooperation.

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# Evaluation on the Core Competitiveness of Listed Banks in China Based on Grey Relational Degree

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**Abstract**-This paper aims at selecting indicators, which is based on China's a-share market annual report data of 16 listed banks in 2015, according to the three principles: rationality, data availability and feasibility. After referring to other related researches, we choose the 14 indicators: operating income, net profit, net assets yield, the average return on total assets, cost-income ratio, non-performing loan ratio, capital adequacy ratio, net assets per share, earnings per share, net profit growth rate, net growth rate, growth rate of total assets and shareholders' equity ratio, asset-liability ratio. We carry on comprehensive evaluation of listed Banks in grey correlation analysis method and do data processing with SPSS software and mecGRAY software. Thus, we can give sorts of comprehensive benefits of 16 listed Banks and put forward some suggestions for stock investors and listed banks.

**Index Terms**-Grey relational analysis, Coefficient of variation, Core competitiveness

## 1. INTRODUCTION

Banking industry is an important industry in our country, however, international banking has impacted greatly on the country's banking industry. In order to enrich the capital in the commercial bank, improve the management quality of the industry, and to strengthen its overall strength, commercial banks publicly listed their company as a move of strategic brilliance. As of August 2016, the bank of China and 16 other banks have listed on the domestic, however, the subsequent development of these listed commercial banks and possible problems arising requires additional attention. With the rapid speeding up of the financial globalization, foreign Banks relentlessly enter into the Chinese market, leading to the intense competition of banks in our country. To ensure better development there is a need to inject new vitality into the market, and be able to pinpoint the inherent problems in time. Also, there is a practical significance to conduct a comprehensive evaluation research on how to accurately and objectively assess the listed commercial Banks in China. Since the 1980s, riding on the continuous wave of financial innovation, the domestic listed Banks are able to attain rapid development, and as such,

domestic and foreign scholars are able to present a series of research results.

Nguyen from the external environment factors, the banking industry homogenization of the increasingly fierce competition in the degree of financial disintermediation deepening spread and narrowed sharply in the income situation, banks have to develop non interest business to expand the source of profits<sup>[11]</sup>. Dieboid based on the variance decomposition of the network topology structure, a systematic method for measuring the correlation is proposed<sup>[10]</sup>. Lanyun Li, Feifei Zhang selected indicators from the profitability, operational capacity, growth capacity, solvency, asset quality and capital adequacy ratio to build evaluation system, using factor analysis method to calculate the score of 10 listed banks competitiveness, objectively making a scientific and reasonable evaluation<sup>[7]</sup>. Hongbing Ouyang it is concluded that the whole banking system has a high degree of systematic correlation and a high overall risk level<sup>[3]</sup>. Yanying Zhang the whole idea of supply side reform of commercial banks is to optimize the allocation of financial resources and improve the core competitiveness of commercial banks<sup>[2]</sup>.

This paper will comprise of the data of 16 Banks on the basis of the 2015 annual report data of listed companies, by selecting 14 financial indicators to conduct an in-depth study of the 16 listed Banks, and further produce a comprehensive evaluation of the listed companies which of these Banks are out of the 16 listed Banks comprehensive performance, and information on the advantages and disadvantages of each of the company. Hence, put forward feasible suggestions to the development of these listed companies accordingly. Thereby, hoping that this paper will be able to be a valuable reference for investment decisions for these 16 listed banks' current investors and its potential investors.

## II INDEX SYSTEM AND DATA SOURCE

### A. Index Selection

TABLE 1 COMPREHENSIVE EVALUATION INDEX SYSTEM OF A-SHARE LISTED BANKS

primary	secondary	unit	quality
full-year results	operating income	million yuan	positive indicator
	net profit	million yuan	positive indicator
	return on equity	%	positive indicator
profitability	the average return on total assets	%	positive indicator
	cost-income ratio	%	inverse indicator
capital indexes	non-performing loan ratio	%	inverse indicator
	capital adequacy ratio	%	appropriate indicator
a share indexes	net assets per share	yuan	positive indicator
	earnings per share	yuan	positive indicator
growth ability	net profit growth rate	%	positive indicator
	growth rate of net assets	%	positive indicator
	growth rate of total assets	%	positive indicator
debt paying ability	equity ratio	%	positive indicator
	asset-liability ratio	%	appropriate indicators

To evaluate the performance of listed companies, domestic and foreign academic circles has conducted a comprehensive research and develop some relatively mature theoretical system. The correctness of the comprehensive evaluation index, it will directly affect the accuracy of evaluation results. So the selection of evaluation index must have amount, controllable and practicability. This report, considering the combination of the absolute index and relative index, index of contact between the comparability and benchmark data availability, from the full-year results, profitability, capital index, a share index, growth ability, debt paying ability the six aspects of indicators were selected. At the same time, this article also reference to other relevant research results, ultimately chose operating income x1, net profit x2, return on equity x3, the average return on total assets x4, cost-income ratio x5, non-performing loan ratio x6, capital adequacy ratio x7, net assets per share x8, earnings per share x9, net profit growth rate x10, growth rate of net assets x11, growth rate of total assets x12,

shareholders' equity ratio x13, asset-liability ratio x14. The selection of specific indicators, classification and the properties, see Table 1.

*B. Data Source*

This report data from sina finance and economics website. 16 a-share listed Banks in China have given the 2015 annual report and financial statements and other relevant data, with real credibility. To sort out so the original financial data for the analysis of the 14 listed Banks of the concrete index values.

III ESTABLISH MODEL

In order to ensure the quality of the built model and get the right research analysis, to eliminate the effects of various index dimensional inconsistent, first you need to in front of the comprehensive evaluation of each index dimensionless processing, make each index between comparable. Data transformation is commonly used in correlation analysis method of initial value transformation method, the mean transformation method, full transformation method, unitary transformation method, multiple transformation method, maximum terrible transformation method, standardized method and interval value transformation method. This article USES the initial value transformation method for data processing, calculation as shown in formula (1).

$$Y_i(k) = \frac{X_i}{X_1}, \quad (i=1, 2, 3, \dots, m) \tag{1}$$

A correlation analysis to formulate reference data column (mother factor time series), reference data column for  $x_0$ , often expressed as commonly:

$$X_0 = \{x_0(1), x_0(2), \dots, x_0(n)\}$$

Correlation analysis of comparative sequence (a factor in time series) often remember as  $x_i$ , usually expressed as:

$$X_i = \{x_i(1), x_i(2), \dots, x_i(n)\} \quad i = 1, 2, \dots, n$$

For a reference data column  $x_0$ , there are a number of comparative data column  $x_i$ , expressed by the following relations at various points in each curve compare with the reference curve of the poor:

$$\zeta_i(k) = \frac{\min_i \min_k |x_0(k) - x_i(k)| + \xi \max_i \max_k |x_0(k) - x_i(k)|}{\max_i \max_k |x_0(k) - x_i(k)| + \xi \min_i \min_k |x_0(k) - x_i(k)|} \tag{2}$$

In type(2),  $\zeta_i(k)$  is the first time is the reference curve  $x_i$  and curve  $x_0$  relative difference, this kind of difference is called  $x_i$  and  $x_0$  in k moment correlation coefficient. Coefficient  $\xi$  for resolution,  $\xi \in [0, 1]$ . And introduced it in order to adjust the extremum effect

on the calculation results. When in actual use, we should distinguish coefficient according to the correlation degree between the sequences. Generally  $\xi \leq 0.5$  take the most appropriate.

Assuming that:

$$\Delta \min = \min_i \min_k |x_0(k) - x_i(k)|, \quad \Delta \max = \max_i \max_k |x_0(k) - x_i(k)|$$

$\Delta \min$  and  $\Delta \max$ , respectively, for the moment with  $x_0$  and  $x_i$  minimum absolute difference and the maximum absolute value of difference. Which are:

$$\xi_i(k) = \frac{\Delta \min + \xi \Delta \max}{|x_0(k) - x_i(k)| + \xi \Delta \max} \quad (3)$$

To distinguish the type of  $\xi$  coefficient,  $\xi = 0.1 \sim 1.0$ , take  $\xi = 0.5$ .

IV EMPIRICAL ANALYSIS

A. Index Weight

For each index data variation coefficient calculation is as follows:

$$V_i = \frac{\sigma_i}{\bar{x}_i} \quad (i = 1, 2, \dots, n) \quad (4)$$

In type(4),  $V_i$  is the coefficient of variation of the  $i$  index;  $\sigma_i$  is the standard deviation of the  $i$  index;  $\bar{x}_i$  is the average number of  $i$  index. Then the weight of each index is:

$$W_i = \frac{V_i}{\sum_{i=1}^n V_i} \quad (5)$$

So when calculating the weight of each financial index, we can use the formula (4) to calculate the coefficient of variation of each index, and then use the formula (5) to calculate the weight of each index, see Table 2.

TABLE 2 WEIGHT DISTRIBUTION OF EACH INDEX

primary	secondary	weight	total
full-year results	operating income	0.16	0.34
	net profit	0.18	
	return on equity	0.02	
profitability	the average return on total assets	0.02	0.06
	cost-income ratio	0.02	
	non-performing loan ratio	0.04	
capital indexes	capital adequacy ratio	0.02	0.06
	net assets per share	0.08	
a share indexes	earnings per share	0.09	0.17
	net profit growth rate	0.19	
	growth rate of net assets	0.08	
growth ability	growth rate of total assets	0.08	0.35
	equity ratio	0.02	
debt paying ability	asset-liability ratio	0	0.02

Because the gap between each listed Banks asset-liability ratio is very small, we will weed out the index when we carry on the comprehensive evaluation in the actual analysis, then do grey correlation analysis with the rest of the 13 indexes.

B. Optimal Index

In selection of the 13 effective sequence, there were 10 indicators are positive indicators, respectively is: operating income, net profit, net assets yield, the average return on total assets, net assets per share, earnings per

share, net profit growth rate, net growth rate, growth rate of total assets and shareholders' equity ratio; Two indicators is inverse indicator, respectively is: the cost income ratio and non-performing loan ratio; Measurable indicators have capital adequacy ratio. According to the principle of determining the optimal index, we can determine the reference sequence.

$X_0 = (697647, 277720, 18.89, 1.3, 21.59, 0.83, 8, 15.292, 2.665, 24.9181, 59.8776, 40.4554, 8.1069)$

C. Standardization of the Data Processing

TABLE 3 COMPREHENSIVE EVALUATION RESULTS

bank name	correlation	comprehensive ranking
Bank of nanjing	0.944547	1
Ningbo bank	0.832413	2
Shanghai pudong development bank	0.817993	3
Societe generale bank	0.814885	4
China merchants bank,	0.797494	5
Ping an bank	0.797154	6
Industrial and commercial bank	0.793077	7
Construction bank	0.786954	8
Bank of Beijing	0.785635	9
Huaxia bank	0.778199	10
The bank of China,	0.774617	11
Minsheng bank	0.774032	12
Agricultural bank of China	0.773643	13
China citic bank	0.765921	14
Bank of communications	0.764078	15
Everbright bank	0.759391	16

Due to the dimension of the indexes we selected, we can not direct comparison of each index, so to measure dimensionless processing. This report by the method of initial value, selected indicators of standardized treatment Taking resolution  $\rho = 0.5$ , Based on the above data and applied mecGRAY software analysis, we can get the following results of the analysis, see Table 3.

By Table 3 shows: the correlation coefficient of nanjing bank is 0.945, the biggest correlation coefficient of the 16 banks. so we can conclude that synthetically consider the six aspects of indicators, nanjing bank has the best comprehensive performance; Followed by the bank of ningbo, the correlation coefficient is 0.832; the third is Shanghai pudong development bank, and the correlation coefficient is 0.818; Then the correlation coefficient of societe generale bank is 0.815; Everbright bank is ranked last, and the correlation coefficient is 0.759. After Shanghai pudong development bank, the correlation coefficient difference between these banks is not big

shows that the performance gap between these banks is relatively small.

## V CONCLUSION AND SUGGESTION

According to above analysis results and the actual situation of the Banks, in this paper, some related conclusions and policy Suggestions are presented as following:

(1) Nanjing and ningbo bank belong to local Banks, annual operating income and net profit are not too big. But because of the two Banks' strong profitability and growth ability, the two Banks are in the top of the overall comprehensive evaluation results and the development prospect are also very good.

(2) Shanghai pudong development bank and societe generale bank have a higher profitability and earnings per share, they belong to the blue chips with high yield and strong expansion ability. And the two bank's capital structure is relatively stable, so we can consider that they have good development prospects.

(3) Compared with four banks described before, some state-controlled Banks' Performance like bank of China, construction bank, agricultural bank and so on are less, although these Banks' capital is stronger, may be they can not immediately adapt to the status quo of e-commerce nowadays, and their enterprise transformation are not so active, and their growth ability and profitability are slightly less, the corresponding comprehensive performance ranking of these banks are also relatively in the rear.

(4) Ranked the last two banks are the bank of communications and everbright bank, the two Banks of Per share index, full-year results, profitability in general, and there is no other special advantage index, so the two Banks are low-ranking and less comprehensive benefit.

In combination with the above conclusions, this paper puts forward the following countermeasures:

(1) Improve capital adequacy ratio. Bank's capital is the foundation of the survival and development of the bank, at the same time, the size of Banks strength size also affects the competitiveness of the bank. So proposal nanjing bank, bank of ningbo and other smaller Banks can through the share capital and acquired or merged with other Banks to increase capital, and improve the competitiveness of the bank. Second, larger Banks for capital, such as China construction bank, industrial and commercial bank, etc., should focus on optimizing the capital structure, in order to resolve the bad assets, asset reorganization to reduce risk assets, and thus improve the quality of assets.

(2) Promote business innovation ability. First of all, listed Banks should strengthen product innovation, technological innovation and service innovation to adapt to the modern fast-changing market and network technology development. The bank of China, construction bank and other state-owned Banks should take advantage of its scale advantage to tout its electronic commercial products, financial derivatives, and actively conform to the trend of The Times. The bank of nanjing, ningbo and other smaller banks should make efforts to overcome the

limitation of the physical network, and make full use of the Internet, mobile phone and other modern information circulation tool, add online banking, mobile banking, as well as the use of software such as QQ, WeChat and, in turn, expand the scale of the customer, improve their competitiveness. Second, China's listed Banks still need to vigorously develop intermediary business, use derivatives for financial innovation, actively expand credit commitment, third-party depository, financial advisers, structured finance, such as business, to increase the proportion of the fee and commission income.

(3) Promote environmental adaptation ability. The trend of globalization and economic integration makes the listed Banks in our country face the domestic and international competition pressure surged, which requires Banks to have a macro environment adaptability, and gain a foothold in the competitive market. Although nanjing bank and ningbo bank have no advantage in terms of scale, its management structure is reasonable, and they can also actively conform to the trend of The Times, constantly improve their own structure, innovative new products. So the comprehensive competitiveness of the Banks are larger. The bank of China, China construction bank and other big state-owned Banks, the structures of these banks are difficult to be changed or transformed, and they may not be sensitive to the change of the market. So for large Banks, shall establish a special departments to study and analyze the changes in the macroeconomic environment and the rules of law environment. Setting up research group to trade competitors' products and technology, and develop more perfect financial service feedback mechanism.

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# Intelligent Diagnosis Method for Rotating Machinery based on Feature Extraction and Particle Swarm Optimization

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**Abstract**—This paper proposes a novel method of intelligent condition diagnosis for rotating machinery using non-dimensional symptom parameter (NSP) and particle swarm optimization (PSO) to detect faults and distinguish fault types at an early stage. NSPs in the frequency domain are defined for reflecting the features of vibration signals measured in each state. The state identification for the condition diagnosis of rotating machinery is converted to a clustering problem of the values of the NSPs, calculated from vibration signals in different states of the machine. PSO is also introduced for this purpose. Moreover, synthetic detection index (SDI) using statistical theory has also defined to evaluate the applicability of the NSPs for the condition diagnosis measured in each state. The SDI can be used to indicate the fitness of a NSP for PSO. A practical example of condition diagnosis for a rolling bearing verifies that the method is effective.

**Index Terms**— Fault Diagnosis; Particle Swarm Optimization; Non-dimensional Symptom Parameter; Synthetic Detection Index

## I. INTRODUCTION

In the field of condition-based maintenance, vibration diagnosis is often used for fault detection and state discrimination for rotating machinery. The condition diagnosis of rotating machinery depends largely on the feature analysis of vibration signals measured for the condition diagnosis because the signals carry dynamic information about the machine state<sup>1,2</sup>. The vibration signals in different states show different features, that is, when plant machinery is in an abnormal state, it will output sign sets corresponding to different faults. If the vibration signals in each state can be automatically identified and classified using these features, intelligent condition diagnosis for plant machinery can be achieved<sup>3,4</sup>.

Roller bearings are an important part of and widely used in rotating machinery. The failure of a rolling bearing may cause the breakdown of a rotating machine, and

furthermore, serious consequences may arise due to the failure. Therefore, fault diagnosis of rolling bearings is most important for guaranteeing production efficiency and plant safety. Although fault diagnosis of rolling bearings is often artificially carried out using time or frequency analysis of vibration signals, there is a need for a reliable, fast automated diagnosis method.

For above reasons, this paper proposes a novel method of intelligent condition diagnosis for rotating machinery using NSP and PSO to detect faults and distinguish fault types at an early stage. The eight NSPs in the frequency domain are defined for reflecting the features of vibration signals measured in each state. The state identification for the condition diagnosis of rotating machinery is converted to a clustering problem of the values of the NSPs, calculated from vibration signals in different states of the machine. PSO is also introduced for this purpose. Moreover, SDI using statistical theory has also defined to evaluate the applicability of the NSPs for the condition diagnosis measured in each state. The SDI can be used to indicate the fitness of a NSP for PSO. A practical example of condition diagnosis for a rolling bearing used in the centrifugal fan system verifies that the method is effective.

## II. NON-DIMENSIONAL SYMPTOM PARAMETERS

When a computer is used for condition diagnosis of plant machinery, symptom parameters (SPs) are required to express the information indicated by a signal measured for diagnosing machinery faults. A good symptom parameter can correctly reflect states and the condition trend of plant machinery<sup>5-7</sup>. Many symptom parameters have been defined in the pattern recognition field. Here, eight NSPs in the frequency domain, commonly used for the fault diagnosis of plant machinery, are considered.

$$p_1 = \frac{\sum_{i=1}^l (f_i - \bar{f})^3 \cdot F(f_i)}{\sigma^3 I} \quad (1)$$

$$p_2 = \frac{\sum_{i=1}^I (f_i - \bar{f})^4 \cdot F(f_i)}{\sigma^4 \cdot I} \tag{2}$$

$$p_3 = \sqrt{\frac{\sum_{i=1}^I f_i^4 \cdot F(f_i)}{\sum_{i=1}^I f_i^2 \cdot F(f_i)}} \tag{3}$$

$$p_4 = \frac{\sigma}{\bar{f}} \tag{4}$$

$$p_5 = \sum_{i=1}^I F(f_i) \tag{5}$$

$$p_6 = \sqrt{\sum_{i=1}^I F^2(f_i)} \tag{6}$$

$$p_7 = \frac{\sum_{i=1}^I \sqrt{(f_i - \bar{f})} \cdot F(f_i)}{\sqrt{\sigma} \cdot I} \tag{7}$$

$$p_8 = \frac{\sum_{i=1}^I f_i^2 \cdot F(f_i)}{\sqrt{\sum_{i=1}^I F(f_i) \sum_{i=1}^I f_i^4 \cdot F(f_i)}} \tag{8}$$

where  $I$  is the number of spectrum line,  $f_i$  is frequency and from 0Hz to the maximum analysis frequency,  $F(f_i)$  is the power spectrum value at frequency  $f_i$ , and  $i=1 \sim I$ .  $\bar{f}$  is mean value of the analysis frequency,

and  $\bar{f} = \frac{\sum_{i=1}^I f_i \cdot F(f_i)}{\sum_{i=1}^I F(f_i)}$ ,  $\sigma$  is standard deviation, and

$$\sigma = \sqrt{\frac{\sum_{i=1}^I (f_i - \bar{f})^2 \cdot F(f_i)}{I}}$$

### III. SYNTHETIC DETECTION INDEX (SDI) FOR EVALUATING SYMPTOM PARAMETERS

The quality of a symptom parameter (SP), which will be used to distinguish two states, such as normal and abnormal state, is evaluated by Discrimination Rate (DR) and Discrimination Index (DI). Supposing that  $x_1$  and  $x_2$  are the SP values calculated from the signals measured in states 1 and 2 respectively, and their average and standard are  $\mu$  and  $\sigma$ . The DR and DI are calculated by

$$DR = 1 - \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{-DI} \exp\left(-\frac{\mu^2}{2}\right) d\mu \tag{9}$$

where DI (Discrimination Index) is calculated by

$$DI = \frac{\mu_2 - \mu_1}{\sqrt{\sigma_1^2 + \sigma_2^2}} \quad \text{or} \quad DI = \frac{x_2 - x_1}{\sqrt{\sigma_1^2 + \sigma_2^2}} \tag{10}$$

It is obvious that the larger value of DI, the larger value of DR will be, and therefore, the better the SP will be. So DI can be used as the index of the quality to evaluate the distinguishing sensitivity of SP.

The number of symptom parameters used for diagnosis and fault types are  $M$  and  $N$  respectively, the synthetic detection index (SDI) is defined as follows:

$$SDI = \sum_{i=1}^{N-1} \sum_{j=i+1}^N \sum_{k=1}^M \frac{|\mu_{ik} - \mu_{jk}|}{\sqrt{\sigma_{ik}^2 + \sigma_{jk}^2}} \tag{11}$$

### IV. PARTICLE SWARM OPTIMIZATION FOR CONDITION DIAGNOSIS

In this study to effectively and automatically distinguish faults for condition monitoring of rotating machinery, a new intelligent condition diagnosis method is proposed based on the NSPs and the PSO, the problem of state identification for the condition diagnosis is converted into the clustering problem of the NSPs calculated by vibration signals measured in different states, which will be solved by the PSO.

#### 4.1 Brief of Particle Swarm Optimization

Particle swarm optimization (PSO) is a population based stochastic optimization technique developed by Dr. Eberhart and Dr. Kennedy in 1995, inspired by social behavior of bird flocking or fish schooling. In past several years, PSO has been successfully applied in many research and application areas<sup>8,9</sup>.

PSO algorithm is based on the groups, and according to the environmental fitness, individual in groups will be moved to the good region. The algorithm evaluates the optimal result by using evolutionary fitness function of group, and each particle in the algorithm has a fitness value determined by the fitness function, two properties of position and speed that are used to show the position and moving speed of the current articles in the solving space, by the fitness function value corresponding to particle position coordinate determines the performance of particles. In PSO algorithm, each particle adjusts its position according to its own experience, and according to the experience of a neighboring particle, making use of the best position encountered by itself and its neighbor.

In the  $R$ -dimensional search space, the  $i$  particle's space position is defined as follows

$$P(i).location = [X_{i1}, X_{i2} \cdots X_{iR}] \tag{12}$$

The velocity of particle  $i$  is defined as follows

$$P(i).velocity = [V_{i1}, V_{i2} \cdots V_{iR}] \tag{13}$$

The best previous position of particle  $i$  is defined as follows

$$P(i).best = [P_{i1}, P_{i2} \cdots P_{iR}] \tag{14}$$

The best position among all particles experienced is defined as follows

$$g(i).best = [g_{i1}, g_{i2} \cdots g_{iR}] \tag{15}$$

The particle updates the position and velocity according to the following equations:

$$P(i).velocity(t+1) = \omega P(i).velocity(t) + \eta_1 r_1 [P(i).best(t) - P(i).location(t)] + \eta_2 r_2 [g(i).best(t) - P(i).location(t)] \tag{16}$$

$$P(i).location(t+1) = P(i).location(t) + P(i).velocity(t+1) \tag{17}$$

where r1 and r2 are the random numbers between (0, 1), and η1 and η2 are the acceleration which constants the control of how far a particle moves in a single generation. Eberhart et al. suggested the values of η1 = η2 = 2. The inertia weight ω controls the previous velocity of particle, and it is defined as follows

$$\omega = 0.5 + \frac{rand}{2} \tag{18}$$

where rand is random generated number between 0 to 1.

#### 4.2 Weight Particle Swarm Optimization

Although PSO algorithm is easy to realize, the method is easy to trap into local optimum. Shi and Eberhart proposed a linearly decreasing weight particle swarm optimization (WPSO) of which, a linearly decreasing inertia factor was introduced into the velocity of the updated equation from the original PSO [12]. The performance of WPSO is significantly improved over the original PSO because WPSO balances out the global and local search abilities of the swarm effectively. In WPSO, ωl is the inertia weight which linearly decreases from 0.9 to 0.4 through the search process. The equation for the linearly decreased weight is defined as follows

$$\omega_l = \omega_{max} - iteration \times \frac{\omega_{max} - \omega_{min}}{iteration_{max}} \tag{19}$$

In Eq. (23), ωmax is 1, ωmin is 0.1 and Iterationmax is the maximum number of the allowed iterations. The velocity of the updated equation for WPSO is defined as follows

$$P(i).velocity(t+1) = \omega_l P(i).velocity(t) + \eta_1 r_1 [P(i).best(t) - P(i).location(t)] + \eta_2 r_2 [g(i).best(t) - P(i).location(t)] \tag{20}$$

#### 4.3 Fitness function for WPSO

Assume that N is the sample set of vibration signals measured in m different states, the length of N is n, N={s1,s2...sn}. Every sample signal has t identified symptoms (in this paper, the symptoms are P1-P10). Then, the clustering analysis is to divide n sample data into m states, such that the objective function F shown in (21) is minimized.

$$\min F = \sum_{j=1}^m \sum_{i=1}^n \sum_{k=1}^t a_{ij} \|S_{ik} - X_{jk}\|^2 \tag{21}$$

$$X_{jk} = \frac{\sum_{i=1}^n a_{ij} S_{ik}}{\sum_{i=1}^n a_{ij}} \quad (j = 1, 2 \dots m; k = 1, 2 \dots t) \tag{22}$$

$$a_{ij} = \begin{cases} 1 & \text{if } S_i \in \text{state } j \\ 0 & \text{if } S_i \notin \text{state } j \end{cases} \quad (i = 1, 2 \dots n; j = 1, 2 \dots m) \tag{23}$$

In this paper, the procedure for applying the PSO for the condition diagnosis is shown in figure 1.

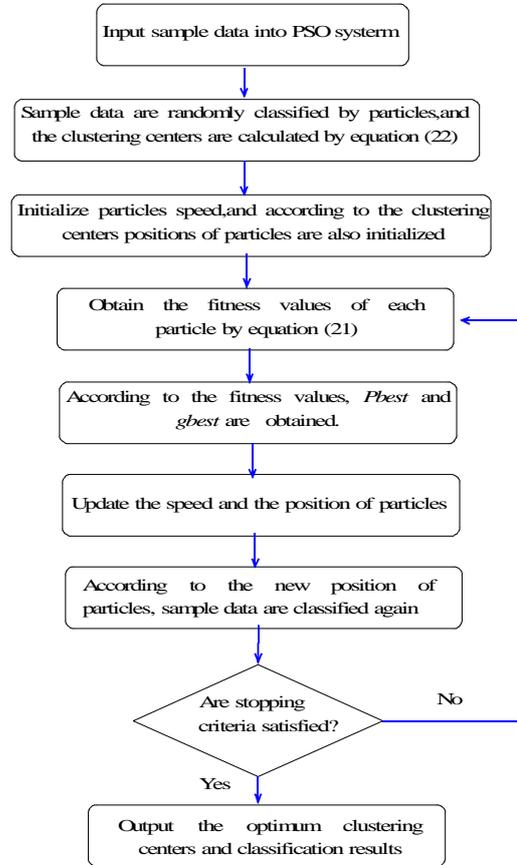


Fig.1. Flowchart of PSO system for condition diagnosis

### V. DIAGNOSIS AND VERIFICATION

Figure 2 shows the centrifugal fan system for rolling bearing fault diagnosis test. The most commonly occurring faults in a rolling element bearing are the outer-race defect, the inner-race defect, and the roller element defect. These fault bearings are shown in figure 3 and were artificially made with the use of a wire-cutting machine. The sizes of the flaw are as follow

Outer-race defect: 0.3 \* 0.25 mm (width \* depth)

Inner-race defect: 0.3 \* 0.25 mm (width \* depth)

Rolling element defect: 0.5 \* 0.15 mm (width \* depth)

In this work the accelerometer (PCB MA352A60) with a bandwidth from 5 Hz to 60 kHz and 10 mV/g output was used to measure the vibration signals of the vertical direction in the normal(N), the outer-race defect(O), the inner-race defect(I), and the roller element defect(R) respectively. The original vibration signals in each state were measured at a constant speed (800 rpm). The sampling frequency of the signal measurement was 50 kHz,

and the sampling time was 20 s.

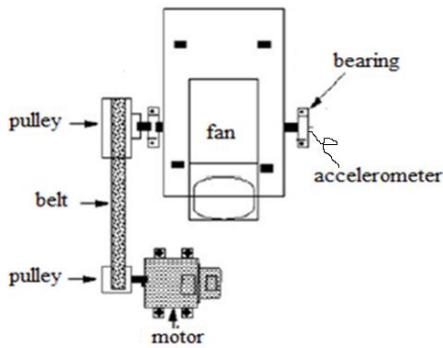


Fig.2. Experimental system for bearing fault diagnosis

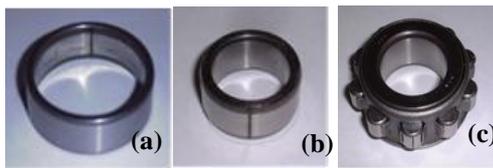


Fig.3. Bearing defects (a) Outer-race defect. (b) Inner-race defect. (c) Roller defect

In this study the good NSPs which have high sensitivity for distinguishing each fault state of the bearing are selected by the method of SDI. As an example, Table1 lists parts of SDIs of NSPs calculated by Equations (1)-(8). The maximum value (128.27) of SDI is obtained in the case of the combination of P1, P5 and P6, and when P1, P5 and P6 are used for distinguishing each state separately, the DIs are larger than 1.62, all of the DRs are larger than 95%. Therefore, the combination of P1, P5 and P6 has high sensitivity for distinguishing each fault state of the bearing.

In this research, the state identification for the condition diagnosis is converted to a clustering problem for the values of the NSPs calculated from vibration signals measured in different states of the bearing. The PSO automatically finds the optimal clustering centers and classify all sample data according to the amount of information around the clustering centers. The purpose of training the PSO is the acquisition of optimum clustering centers. The NSPs calculated using the signals measured in each state were input into the PSO. The PSO converged to the optimum clustering centers. As an example, figure 4 shows the change of the optimum clustering centers while training the PSO for the condition diagnosis of the bearing. In the training process of the PSO, at first, the sample data are classified into normal state, outer-race defect state, inner-race defect state and roller defect state randomly. The fitness values and the clustering centers are calculated by formulas (21)-(23). With increasing iterations, the speed and position (clustering centers) of the particle are updated incessantly, and according to the clustering centers information, the classification of the sample data are also updated. Finally, the optimal clustering centers with a minimum fitness value are calculated. and parts of the training data and their clustering centers are shown in table 2. In the figure 4, the symbols  $\circ$ ,  $\Delta$ ,  $\star$  and  $\diamond$  express the value samples of NSPs in the normal state, outer-race

defect state, inner-race defect state and roller defect state, respectively, and the bigger symbols represent their clustering centers.

Table. 1. SDI of each NSP

NSPs	SDI	DI <sub>max</sub>	DI <sub>min</sub>
P <sub>1</sub> P <sub>2</sub> P <sub>3</sub>	38.98	3.29	0.22
P <sub>1</sub> P <sub>2</sub> P <sub>4</sub>	49.84	8.98	0.22
...	...	...	...
P <sub>1</sub> P <sub>5</sub> P <sub>6</sub>	128.27	17.65	1.62
P <sub>1</sub> P <sub>5</sub> P <sub>7</sub>	110.85	17.65	1.35
...	...	...	...

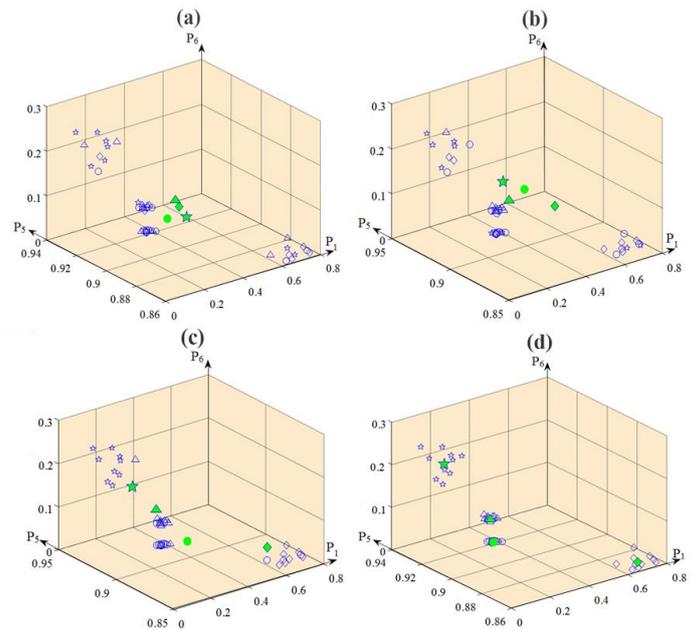


Fig. 4 The change of the clustering centers while training the PSO. (a) At the start of the PSO (b) after 100 iterations (c) after 200 iterations (d) after 300 iterations.

Table. 2. Parts of acquired data of diagnosis for the PSO. (a) Normal state, (b) Outer-race defect state, (c) Inner-race defect state, (d) Roller element defect state.

(a) Normal state					
NSPs			Clustering Center		
P <sub>1</sub>	P <sub>5</sub>	P <sub>6</sub>			
0.372	0.9225	0.0028			
0.394	0.9234	0.0031	0.3828	0.9223	0.0029
0.384	0.9238	0.0029			
...	...	...			
(b) Outer-race defect state					
NSPs			Clustering Center		
P <sub>1</sub>	P <sub>5</sub>	P <sub>6</sub>			
0.462	0.9314	0.1629			
0.429	0.9716	0.1488	0.4352	0.9516	0.1624
0.417	0.9623	0.1560			
...	...	...			

(c) Inner-race defect state					
NSPs			Clustering Center		
P <sub>1</sub>	P <sub>5</sub>	P <sub>6</sub>			
0.174	0.916	0.23114			
0.115	0.904	0.22581	0.1488	0.904	0.2489
0.293	0.915	0.23562			
...	...	...			

(d) Roller element defect state					
NSPs			Clustering Center		
P <sub>1</sub>	P <sub>5</sub>	P <sub>6</sub>			
0.883	0.864	0.000203			
0.796	0.882	0.000373	0.7202	0.8697	0.0003
0.533	0.871	0.000185			
...	...	...			

Table 5. Diagnosis result using proposed method

NSPs			Judge States	Diagnostic accuracy
P <sub>1</sub>	P <sub>5</sub>	P <sub>6</sub>		
0.384336	0.923004	0.002897	N	100%
0.399365	0.920843	0.002894	N	
0.371282	0.923237	0.002956	N	
0.361462	0.923445	0.00278	N	
0.411569	0.919997	0.002918	N	
...	...	...	...	
0.420704	0.929598	0.167619	O	97.5%
0.461678	0.931448	0.162877	O	
0.42853	0.931622	0.14881	O	
0.417	0.932341	0.155985	O	
0.437503	0.929529	0.164929	O	
...	...	...	...	
0.014909	0.915833	0.23104	I	92.5%
0.173918	0.904876	0.22581	I	
0.11468	0.915738	0.22562	I	
0.29314	0.931221	0.24711	I	
0.099783	0.917344	0.24339	I	
...	...	...	...	
1.007424	0.879394	0.000427	R	92.5%
0.882886	0.864373	0.000203	R	
0.796213	0.88158	0.000373	R	
0.533197	0.870905	0.000185	R	
0.514773	0.869139	0.000404	R	
...	...	...	...	

After training the PSO, to verify the diagnostic capability of the proposed method in this paper, the test data measured in each known state that had not been used to train the PSO were used. When inputting the test data into the trained PSO, the PSO classified the test data according to the information of the optimum clustering centers shown in Table 4 and correctly and quickly output

identification results. As an example, some diagnosis results are listed in Table 5. These results verified the efficiency of the intelligent diagnosis method using NSPs and the PSO proposed in this paper.

### VI. CONCLUSIONS

In order to diagnose faults of rotation machinery at an early stage, this paper proposed a novel method of intelligent condition diagnosis for rotating machinery using NSP and PSO to detect faults and distinguish fault types at an early stage. The ten NSPs in the frequency domain were defined for reflecting the features of vibration signals measured in each state. The state identification for the condition diagnosis of rotating machinery was converted to a clustering problem of the values of the NSPs, calculated from vibration signals in different states of the machine. PSO was also introduced for this purpose. Moreover, SDI using statistical theory had also defined to evaluate the applicability of the NSPs for the condition diagnosis measured in each state. The SDI could be used to indicate the fitness of a NSP for PSO. A practical example of condition diagnosis for a rolling bearing used in the centrifugal fan system verified that the method is effective.

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# Selective Cerebral Perfusion in Cardiac Surgery to Aorta

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**Abstract—Objective:** To investigate the feasibility of mild hypothermic-selective cerebral perfusion (MHSCP) in cardiac surgery to aorta. **Methods:** 108 patients who underwent ascending aorta and aortic arch surgery were divided into three groups: deep hypothermic circulatory arrest (DHCA) group (32 cases), deep hypothermic-antegrade selective cerebral perfusion (DHASCP) group (35 cases) and mild hypothermic-antegrade selective cerebral perfusion (MHASCP) group (41 cases). A retrospective analysis of clinical data of these patients was performed, including the method and time of cardiopulmonary bypass (CPB), mortality and rate of complications, and statistical analysis was carried out, to compare the difference among the three groups. **Results:** The CPB time of MHASCP group was lower than that of DHCA group and DHASCP group, showing significant difference ( $184.56 \pm 24.01$  min vs.  $216.94 \pm 25.22$  min vs.  $200.09 \pm 23.80$  min,  $P < 0.05$ ). The re-thoracotomy rate of the MHASCP group was lower than that of the other two groups, with significant differences [4.9% (2/41) vs. 14.3% (5/35) vs. 25.0% (8/32),  $P < 0.05$ ]. There were no significant differences in the incidences of postoperative respiratory insufficiency, renal failure, infection, abdominal complications and paraplegia among them ( $P > 0.05$ ). There were no significant differences in hospital mortality rate, transient and permanent neurological complications among the three groups ( $P > 0.05$ ). **Conclusion:** MHSCP could potentially act as a reliable tool of cerebral protection in cardiac surgery to aorta, which can shorten the CPB time and reduces the re-thoracotomy rate.

**Index Terms—**selective cerebral perfusion, cardiopulmonary bypass, aorta, cardiac surgery, cerebral protection.

## I. BACKGROUND

Cerebral protection is highly likely to play a key role in cardiac surgery to aorta. At present, there are many cerebral protection measures applied to clinical practices. Deep hypothermic circulatory arrest (DHCA) is one of

the most widely adopted approach for cerebral protection. It is easy to operate, with bright view, and it can provide safe and effective cerebral protection, greatly improving the prognosis of operation on great artery. However, the deep hypothermia can cause coagulation abnormalities, renal injury, pulmonary complications, and the cooling and warming process prolongs the cardiopulmonary bypass (CPB) time. Selective cerebral perfusion can provide continuous blood flow to the brain tissues during the operation while no blood supplying to lower body. Therefore, the temperature requirements are not as stringent as the cause without selective cerebral perfusion, even it can be performed under normothermic condition, to reduce the complications caused by hypothermia. In this study, we compared the clinical data of three groups of patients (DHCA, DHASCP and MHASCP groups), and investigated the effect of MHASCP on cerebral protection and other organs and tissues.

## II. METHODS

### *Clinical Data*

Subjects were selected from 108 patients who underwent ascending aorta and aortic arch surgery in Guangdong Cardiovascular Institute and The First Affiliated Hospital of Jinan University, China. Subjects were divided into three groups according to the modes of cerebral protection during the surgery: deep hypothermic circulatory arrest (DHCA), deep hypothermic-antegrade selective cerebral perfusion (DHASCP) group and mild hypothermic-antegrade selective cerebral perfusion (MHASCP). In the DHCA group, there were 32 cases (23 males and 9 females; mean age of  $49.94 \pm 11.82$  years). In the DHASCP group, there were 35 cases (24 males and 11 females; mean age of  $50.29 \pm 11.28$  years). In the MHASCP group, there were 41 cases (28 males and 13 females; mean age of  $47.98 \pm 11.46$  years). There were no significant differences in sex and age among the three groups ( $P > 0.05$ ).

*Cardiopulmonary bypass*

All patients were underwent CPB by using Stockert-III extracorporeal circulation unit, and extracorporeal membrane oxygenation of Medtronic Affinity, with the priming solution containing Plasmalyte-A, blood plasma, 500 mg of Methylprednisolone, 50 mg of Heparin. When the rectal temperature was reduced to 30°C, the ascending aorta was blocked and HTK cardioplegia was perfused. In the DHCA group, patients continued to cool down until the nasopharyngeal temperature at 18°C and rectal temperature at 20°C. In the DHASCP group, patients continued to cool down until nasopharyngeal temperature and rectal temperature at about 25°C, and in the MHASCP group, patients continued to cool down at approximately 30°C. When circulatory arrest was performed, arterial blood pump perfusion was firstly stopped, lungs were filled with air by anesthesiologists, and the hepatic region was squeezed by operator, and then blood in the body flowed back as much as possible to the venous reservoir. The arteriovenous transfusion tubes were clamped for cycling of oxygenator. In the DHCA group, the patients were subject to icing on their heads. After recovery of CPB, blood flow rewarming was started after hypothermic circulation for 10 min, and 250 mL of 20% mannitol was added. All patients in the DHCA and DHASCP groups were under pH-stat blood gas management during the process of cooling, and under  $\alpha$ -stat during the maintenance and rewarming process. Both the cooling and rewarming processes lasted 20 min. The arterial partial pressure of oxygen was maintained about 200 mmHg (1 mmHg = 0.133 kPa), and the partial pressure of carbon dioxide maintained at 40 mmHg to 45 mmHg. The continuous venous oxygen saturation was monitored and maintained at over 65% and the hematocrit (HCT) was at 28% to 30%. The patients underwent selective cerebral perfusion were obtained aortic root and innominate arterial intubation simultaneously, which were connected at the arterial perfusion tube using a three forked connection. When temperatures fall to targeted levels, brain perfusion was performed through innominate arterial intubation alone,

the left subclavian artery and left common carotid artery were blocked in order to prevent arterial steal. The perfusion flow was adjusted from 10 mL/kg, to maintain the right radial artery pressure at 40 mmHg to 60mmHg. During the CPB, the Trendelenburg position was maintained. Conventional ultrafiltration was adopted, and HCT was more than 30% when the circulation was stopped.

*Statistical analysis*

A retrospective analysis of clinical data of 108 cases was performed, to compare the differences in the cardiopulmonary bypass method and method, mortality and rate of complications under different cerebral protection ways of DHCA, DHASCP and MHASCP. The obtained data were expressed as mean  $\pm$  standard deviation (SD). The differences in the CPB time, aortic cross-clamp (ACC) time, cerebral protection time were compared using one-way analysis of variance (ANOVA), and q test was performed for pairwise comparison, chi-square test was adopted for other observation Indexes. A *P* value of < 0.05 was considered statistically significant. Statistical analyses were performed with SPSS statistics software package, version 13.0 (SPSS Inc., Chicago, Illinois, USA).

III. RESULTS

The baseline data of the three groups were compared, showing no significant difference between them (*P* > 0.05), as shown in Table 1. The CPB time, ACC time and cerebral protection time of the three groups were shown in Table 2, and the temperatures presented as the mean values of rectal and nasopharyngeal temperatures in the DHCA group, DHASCP group and MHASCP were at 17.82  $\pm$  0.58°C, 22.66  $\pm$  0.82°C and 28.42  $\pm$  0.83°C, respectively. The other observation Indexes, including the numbers of death, neurological complications, respiratory insufficiency, renal failure, abdominal complications and postoperative infections of the three groups were shown in Table 3.

TABLE 1.

BASELINE DATA OF THE THREE GROUPS [N(%)].

Group	N	Reoperationa	Emergency	Type A Dissection	Marfan syndrome	Transient neurological diseases	Permanent neurological diseases	History of smoking
DHCA group	32	5(15.6)	11(34.4)	11(34.4)	2(6.3)	1(3.1)	2(6.3)	16(50)
DHASCP group	35	6(17.1)	9(25.7)	11(31.4)	3(8.7)	2(5.7)	3(8.6)	18(51.4)
MHASCP group	41	8(19.5)	13(31.7)	12(29.3)	3(7.3)	1(2.4)	3(7.3)	21(51.2)

Group	N	History of primary hypertension	History of hyperlipidemia	Diabetes	Peripheral vascular disease	CHD <sup>a</sup>	Renal insufficiency <sup>b</sup>	Chronic lung disease
DHCA group	32	25(78.1)	13(40.6)	1(3.1)	2(6.3)	7(21.9)	2(6.3)	6(18.8)
DHASCP group	35	25(71.4)	15(42.9)	2(5.7)	1(2.9)	6(17.1)	3(8.6)	6(17.1)
MHASCP group	41	27(65.8)	16(39)	2(4.9)	2(4.9)	8(19.5)	2(4.9)	7(17.1)

<sup>a</sup> Coronary heart.

<sup>b</sup> Renal insufficiency was defined as the serum creatinine concentration was more than 120  $\mu\text{mol/L}$ .

TABLE 2.

THE CPB TIME, ACC TIME AND CEREBRAL PROTECTION TIME OF THE THREE GROUPS.

Group	N	CPB time	ACC time	Cerebral protection time
DHCA group	32	216.94 $\pm$ 25.22	97.19 $\pm$ 10.90	59.88 $\pm$ 6.60
DHASCP group	35	200.09 $\pm$ 23.80	103.49 $\pm$ 13.25	62.28 $\pm$ 6.06
MHASCP group	41	184.56 $\pm$ 24.01 <sup>*<math>\Delta</math></sup>	107.66 $\pm$ 21.71	62.73 $\pm$ 6.02

<sup>\*</sup> Compared with DHCA group ( $P < 0.05$ ).  <sup>$\Delta$</sup>  Compared with DHASCP group ( $P < 0.05$ ).

TABLE 3.

THE OBSERVATIONAL INDEXES OF THE THREE GROUPS [N (%)].

Group	N	Death	Transient neurological	Permanent neurological	Thoracotomy	Respiratory
			complications <sup>a</sup>	complications <sup>b</sup>	for hemostasis <sup>c</sup>	insufficiency <sup>d</sup>
DHCA group	32	4(12.5)	5(15.6)	2(6.3)	8(25)	7(21.9)
DHASCP group	35	3(8.6)	5(14.3)	2(5.7)	5(14.3)	9(25.7)
MHASCP group	41	4(9.6)	7(17.1)	3(7.3)	2(4.9) <sup>*<math>\Delta</math></sup>	8(19.5)

Group	N	Renal failure <sup>e</sup>	Infections <sup>f</sup>	Abdominal complications	Paraplegia
DHCA group	32	1(3.1)	6(18.8)	2(6.3)	1(3.1)
DHASCP group	35	2(5.7)	5(14.3)	2(5.7)	0
MHASCP group	41	2(4.9)	5(12.2)	3(7.3)	1(2.4)

<sup>\*</sup> Compared with DHCA group ( $P < 0.05$ ).  <sup>$\Delta$</sup>  Compared with DHASCP group ( $P < 0.05$ ).

<sup>a</sup> The following symptoms, including mental disorder, anxiety, talk nonsense, prolonged unresponsive, episodic Parkinson's syndrome, without definite neurological signs occurred, it could be defined as transient neurological complications.

<sup>b</sup> The permanent neurological complications should be determined by neurological deficits and new lesions confirmed from CT.

<sup>c</sup> Thoracotomy was performed for hemostasis if the pleural fluid exceeded 200 mL/h in the first three hours after surgery or exceeded 500 mL in one hour after surgery.

<sup>d</sup> It could be considered respiratory insufficiency when a ventilator still need to be used over 48 hours after surgery.

<sup>e</sup> Patients suffered from renal insufficiency that need dialysis were recorded as renal failure.

<sup>f</sup> Patients were diagnosed with bacterial infections by bacteriological tests.

#### IV. DISCUSSION

Recently, with the development of science and technologies, the perfusion methods have been greatly improved in the field of cardiac surgery, which reduces the mortality rate and the incidence of complications, especially with the extensive applications of DHCA, the safety and prognosis of ascending aorta and aortic arch surgery have been greatly improved, but the risk that lead to brain injury still exist. Researchers are paying more attentions to the incidence of neurological complications and the effect of circulatory arrest time on the prognosis. Thus, the development of novel perfusion techniques for cerebral protection was attempted. Selective cerebral perfusion (SCP) can provide continuous blood flow to the brain tissues without time limit. However, according to relevant literatures, it cannot reduce the occurrence of neurological complications, and even the morbidity of transient neurological complications had risen, which is possibly associated with the facts that hypothermia reduces the ability of red blood cells to carry oxygen and can cause the inhibition of the self-regulating ability of blood vessels. Therefore, we have adopted MHASCP for intraoperative cerebral protection.

The results of this study showed that, compared with DHCA and DHASCP, MHASCP decreased the CPB time and re-thoracotomy rate ( $P < 0.05$ ). However, there was no significant difference in the effect on other organs among them ( $P > 0.05$ ). Hypothermia reduced brain metabolism and energy consumption, delayed the process of degeneration of tissue cells, such as respiratory burst, apoptosis and necrosis, microglia activation, oxidative stress, inflammatory response, and so on. The mild hypothermia can protect the balance between cerebral blood flow and metabolic rate, but the deep hypothermia can disrupt the cerebrovascular regulatory effect, leading to abnormal brain tissue metabolism and oxygen consumption [1]. It has been well documented that SCP could reduce neurological complications with a substantially lower in-hospital mortality rate [2, 3]. Whereas the study of Kamiya suggested that SCP could not show significant advantages in cerebral protection [4]. However, in recent years, mild hypothermic or normothermic SCP has been adopted in many heart centers, with presenting good effect [5, 6], and these results were consistent with that of our study. Our analysis suggested that CPB time in the MHASCP group was significantly lower than that in the DHASCP group and DHCA group, with significant difference ( $P < 0.05$ ), indicating that CPB time was closely related to the temperature. Harrington et al. also indicated that CPB time was in inverse proportion to the

temperature [7]. Mild hypothermia could significantly shortened the cooling and rewarming process, and reduced the CPB time. However, Kamiya et al. [4] believed that the surgical operation affected the CPB time since many operations were performed during the course of cooling and rewarming, and thus, the CPB times at different temperatures were not significantly different. The complexity of surgical operation, other lesions that need to be cured and operating habits in different centers would produce the differences, which need to be further studied. However, theoretically, we have uncovered more reason to believe that the cooling and rewarming process will affect the CPB time.

In this study, the incidence of paraplegia was low in all three groups, and there was no difference in paraplegia among the groups ( $P > 0.05$ ), which indicated that all three techniques were effective in protecting the spinal cord. The spinal cord and the brain tissue easily suffer from ischemic injury, since which both are composed of nerve cells. Under deep hypothermia and circulation arrest, the metabolism of nerve cells was at the minimum, and thus, it would not cause significant spinal cord injury in a period of time, which was exactly the same of the brain tissues. In the case of mild hypothermia, because part of the spinal cord blood supply was from the vertebral artery and internal carotid artery, blood flow partly pass through these arteries to reach the spinal cord, and even reach the descending aorta for perfusion of spinal cord and abdominal organs by passing the collateral vessels during the process of SCP [8]. In addition, hypothermia could reduce the metabolism of the spinal cord, decreasing of the metabolism by about 7% accompanied by lowering temperature 1°C. Consequently, even under the mild hypothermic condition, the metabolism of the spinal cord was reduced by nearly a half. Therefore, maybe it is the main mechanism of spinal cord protection. However, such speculations surely warrant further investigations.

Furthermore, the incidence of complications in other organs was very low in all the three groups, and there was no significant difference among them ( $P > 0.05$ ), which was consistent with the results of Kamiya et al. [4], suggesting that mild hypothermia could achieve good protective effect on the abdominal organs. Abdominal organs, such as liver, kidney, small intestine, and so on, have stronger tolerance to ischemic injury than brain and heart, and these organs can tolerate a certain period of ischemia under normothermic conditions, without severe injury. The recovery of respiratory functions after surgery is affected by many factors, and reducing postoperative bleeding can promote the recovery of pulmonary vascular functions. Moreover, the recovery of the nervous system functions is also conducive to the discharge of respiratory secretions [3]. In our study, there

was no significant difference in the recovery of respiratory system among the groups, which might be affected by other factors.

It is well known that the effect of deep hypothermia on the clotting system is very obvious [9], but in clinical practice, the results of various reports are not consistent. Some studies showed that the deep hypothermia was no apparently associated with the postoperative bleeding and re-thoracotomy, while some suggested that rates of re-thoracotomy under different temperatures were different [4]. We found that, the re-thoracotomy rate in the MHSCP group was lower than that of the other two groups, and these operations were performed by the same team, thus, the influence of surgical operations effect on results could be ruled out. We believed that it may be related to the factors as below, firstly, hypothermia at different temperatures may have the effect on clotting, and secondly, the decrease of CPB time may reduce the effect on the coagulation system.

## V. CONCLUSION

It has been widely recognized for the application of SCP in the cardiac surgery to aorta. Whether under mild hypothermic or deep hypothermic conditions, effective cerebral protection could be achieved. Even so, the physiological changes caused by SCP without perfusion of other organs need further studies. There are a lot of different opinions on the clinical applications of this technique, such as flow, pressure, temperature, blood gas management mode, intubations. However, our study still clearly demonstrated that MHSCP is a safe and effective cerebral protection method that shortens the CPB time and reduces postoperative re-thoracotomy rate.

## COMPLIANCE WITH ETHICAL STANDARDS

### *Conflict of Interest*

The authors declare that they have no conflicts of interest.

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### *Ethical Approval*

This study was approved by the human research ethics

committee of Jinan University, Guangzhou, China, as well as those of co-operating hospitals and was performed in accordance with the principles of the Declaration of Helsinki.

### *Informed Consent*

Informed consent was obtained from all individual participants included in the study.

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