

Collaborative Filtering Algorithm and Factors Analysis of Professional Growth of Innovative Talents Based on Data Mining Technology

Qian Cheng^{1,2}

¹*School of Business Administration, Zhejiang Gongshang University, Hangzhou 310018, Zhejiang, China*

²*Zhejiang Financial College, Hangzhou 310018, Zhejiang, China
qc2018@163.com*

Abstract

With the development of information technology, technology mining technology can help users to find the needed information accurately and efficiently. In this paper, the author makes factors analysis of professional growth of innovative talents based on data mining technology. Knowledge innovation is the starting point of scientific and technological innovation, and the development of innovative talents is the most important and the scarcest resource for enterprises. By analyzing the professional growth of innovative talents, we construct the evaluation index system of innovative talents. The conclusion proves that the balance between supply and demand of enterprise and personal professional growth is the important factor to promote organizational technology progress and the career development of employees.

Keywords: *Data mining, Professional growth, Knowledge discovery, Innovative talents*

1. Introduction

Innovation is the soul of a nation's progress and an inexhaustible motive force for the prosperity of a country. Improving the capability of independent innovation, building an innovative country is the core of the national development strategy, and the key to improve the comprehensive national strength [1-2]. The competition of comprehensive national strength between countries in the world is actually the competition of science and technology. It is the breadth and depth of science and technology innovation competition. Technological innovation includes three levels of innovation, that is, the innovation of scientific and technological knowledge; the production of the material and technological conditions of innovation; human quality and labor skills innovation [3]. Knowledge innovation is the starting point and the source of innovation of science and technology, knowledge of science and technology is first transformed into a means of material production, knowledge of science and technology and material means of production and producers work methods and skills, transformation reflects the science and technology into real productivity mechanism. Science and technology innovation is the main source of enterprise's core competitiveness [4-5]. It can make the enterprise's production possibility frontier move, for the enterprise in a certain period of time to create "monopoly profits", and promote the enterprise to realize the organization innovation and management innovation. The main body of scientific and technological innovation is the human, scientific and technological achievements more and more reflect the characteristics of the "people". In enterprise production elements of the combination of contracts, is committed to achieve scientific and technological innovation of human capital, namely, science and technology innovation talents through integration and innovation of technology, skills and knowledge, to enable enterprises to become a leader

in a certain period of time, a domain specific, and their own also grow as the enterprise is the most important, the most scarce, most difficult to replace, the most difficult supervised one of the factors of production. Therefore, scientific and technological innovation oriented talents should share and participate in the distribution of residual claims and residual control rights [6]. How to mobilize the enthusiasm of scientific and technological innovation oriented talents of independent innovation has become one of the core issues of modern enterprises to obtain and maintain the core competitiveness.

In the technology independent innovation enterprise, with the organizations increasingly flat, no boundary occupation career has become an inevitable trend; people pay more and more attention to the professional growth. R & D personnel as the backbone of the enterprise technology independent innovation and their professional growth of subjective perception will change following the organizational context, and the lack of understanding of the R & D personnel career growth needs, will dampen their enthusiasm for innovation. Therefore, it is particularly important to study the subjective and objective cognition of R & D professionals [7]. Perspective of antecedent variables that personal and environmental factors will affect employee career growth, personal characteristics affect the career, structure and social factor plays a stronger role in the decision. In dynamic view, with the dynamic development of time, the specific professional power will enhance the understanding of the work of the organization, and to prove the specific career motivation and the pursuit of career development in the dynamic contribution of time[8]. The dynamic perspective emphasizes the employees' subjective perception of career, and studies the influence of the employee's career development needs and their satisfaction on the behavior and attitude of the career development process. From the perspective of career management, good interpersonal strategy and strong self-career strategy can be considered to improve the performance evaluation of the employer, and to gain competitive advantage in the work.

2. Data Mining Theory

2.1. Collaborative Filtering Algorithm

Web2.0 technology development and network service enterprise's rapid rise, for users provide active recommendation function more and more is applied to various portals and network platform, to help users efficiently and accurately find the needed information. With the increasing number of network users and the number of recommended items, the traditional collaborative filtering algorithm in data sparsity, cold start, high dimensional data computing, recommend real-time and other aspects of severe challenges. Collaborative recommendation research based on social network can be divided into two categories: one kind of research is the use of social network information to improve the traditional CF. However, with the increase of network users, the complexity of the distance between users is also very large. Another kind of research is collaborative recommendation from the perspective of "community", which is similar to the traditional collaborative filtering algorithm based on clustering. Collaborative filtering algorithm in the main process is found who can cooperate target users, the traditional collaborative filtering algorithm is to find target users of n a most similar neighbor, in the recommendation process does not distinguish between recent neighbor recommendation ability. Due to the similarity threshold limit or nearest neighbor number restrictions may lead to recommend better ability of neighbor users to access to the recommendation of the nearest neighbor set. Therefore, it is recommended to obtain a better quality of the nearest neighbor set, which needs to consider the similarity between users and the user's recommendation ability. On the other hand, key users of social network in the dissemination of information and guidance plays a contributory role can not be ignored,

key users not only with others sharing the commodity or the service information, also has the ability to influence the attitudes of others.

In this paper, Pearson coefficients are used to calculate the similarity between users, and the Pearson coefficient is based on the user's common scoring items to measure the similarity between users

$$sim(u, v) = \frac{\sum_{i \in I(u) \cap I(v)} (R_{ui} - \bar{R}_u)(R_{vi} - \bar{R}_v)}{\sqrt{\sum_{i \in I(u) \cap I(v)} (R_{ui} - \bar{R}_u)^2} \sqrt{\sum_{i \in I(u) \cap I(v)} (R_{vi} - \bar{R}_v)^2}} \quad (1)$$

Collaborative filtering algorithm in the main process is found who can cooperate target users, the traditional collaborative filtering algorithm is to find target users of n a most similar neighbor, and in the recommendation process does not distinguish between recent neighbor recommendation ability. In the score matrix, each line represents the score vector of each user, and the similarity formula is as follows:

$$sim(u, v) = \cos(u, v) = \frac{u \times v}{|u| \times |v|} = \frac{\sum_{i=1}^n R_{ui} R_{vi}}{\sqrt{\sum_{i=1}^n R_{ui}^2} \sqrt{\sum_{i=1}^n R_{vi}^2}} \quad (2)$$

Due to the similarity threshold limit or nearest neighbor number restrictions may lead to recommend better ability of neighbor users to access to the recommendation of the nearest neighbor set. Therefore, it is recommended to obtain a better quality of the nearest neighbor set, which needs to consider the similarity between users and the user's recommendation ability. By modifying the cosine similarity, the similarity formula between the user u and the user v is calculated as follows:

$$sim(u, v) = \frac{\sum_{i=1}^n (R_{ui} - \bar{R}_u)(R_{vi} - \bar{R}_v)}{\sqrt{\sum_{i=1}^n (R_{ui} - \bar{R}_u)^2} \sqrt{\sum_{i=1}^n (R_{vi} - \bar{R}_v)^2}} \quad (3)$$

On the other hand, key users of social network in the dissemination of information and guidance plays a contributory role cannot be ignored, key users not only with others sharing information of goods or services, but also has the ability to influence the attitudes of others. Predict the user i on the project u score, can be calculated by the neighbor user has a rating of the project, the calculation formula is as follows:

$$P(u, i) = \frac{\sum_{v \in K \cap U(i)} sim(u, v) \times R_{vi}}{\sum_{v \in K \cap U(i)} sim(u, v)} \quad (4)$$

Add the user's average score, to effectively reduce the impact of the degree of difference in the user's score:

$$P(u, i) = \bar{R}_u + \frac{\sum_{v \in K \cap U(i)} sim(u, v) \times (R_{vi} - \bar{R}_v)}{\sum_{v \in K \cap U(i)} sim(u, v)} \quad (5)$$

2.2. Structural Risk Minimization

Data mining (DM), also known as database knowledge discovery (KDD) DSS, is to obtain valid, novel, potentially useful, and ultimately understandable patterns from large amounts of data in a non trivial process, simply, data mining is from the vast amounts of

data mining may have potential value of information technology. The information is may have potential value, decision support, can bring benefits to enterprises, or to find a breakthrough for scientific research

Data mining is an iterative process of human-computer interaction, from the macro data mining mainly consists of 3 parts: data processing, data mining and the results of the interpretation and evaluation.

Mainly consists of the following parts:

1) Question definition: before the start of data mining, first at the same time is also the most important is to understanding in the field of data and business issues. Based on the clear definition, effective problem definition should also contain the results of data mining measure standard, project budget and interpretation.

2) Data preparation: access to the data source to mining, determined for mining data subsets of the data, establishment of data mining base. If the original data warehouse to meet the requirements of data mining, data warehouse is data mining base.

3) Data processing: because the data may be incomplete, noise, random, analyzing the data, the cleaning incomplete data, describe the preliminary analysis, selection and data mining related variables, or variables change.

4) To establish the model: according to the purpose of data mining and the characteristics of the data, select the appropriate model.

5) Evaluation and interpretation: according to the end users for decision-making purposes of data mining information evaluation, choose the best mode, for the existence of redundant or irrelevant patterns to be deleted; can not meet the user requirements, you need to back to a stage. And knowledge and professional combined with interpretation of results.

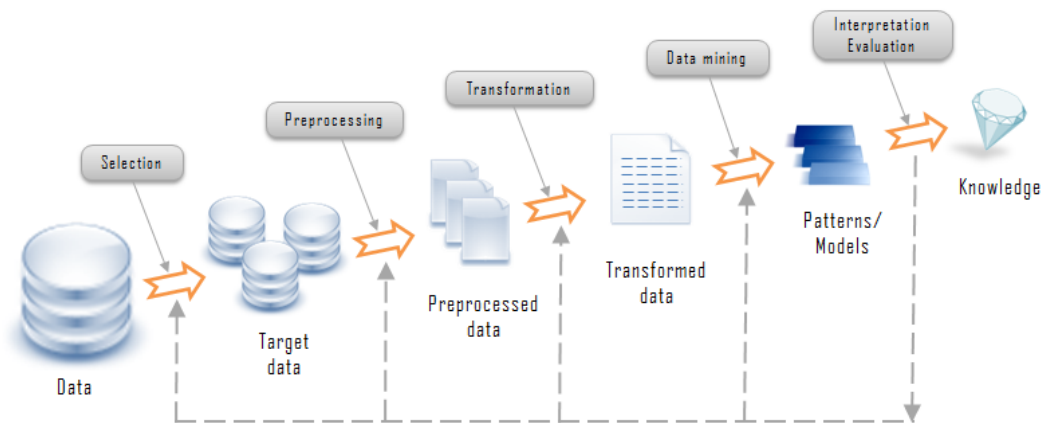


Figure 1. Knowledge Discovery in Database

Artificial neural network is a nonlinear dynamic system, its characteristics lies in the information stored in distributed and parallel collaborative processing. A neural network usually consists of a number of neurons connected widely and, although the individual neurons of extremely simple structure, limited function, but a number of Gods by elements of network system can achieve behavior is extremely rich and colorful. Neural network not only information can be a variety of changes, and information processing at the same time, nonlinear dynamic system itself also in constant change. Often used iterative process describing the evolution of power system:

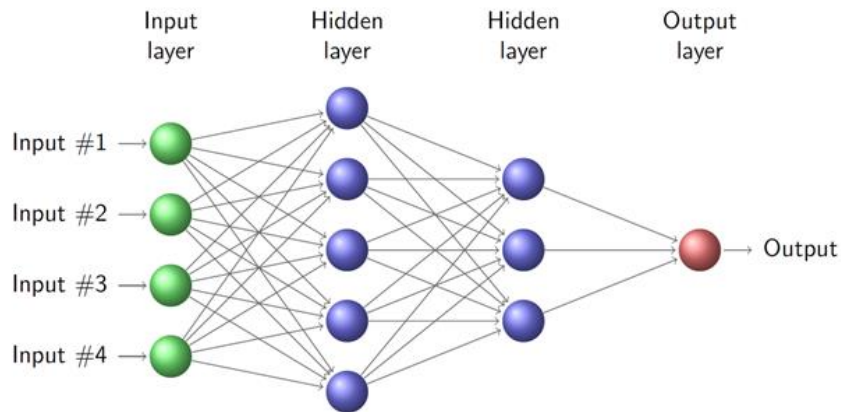


Figure 2. The Neural Network

In the complex target, the massive data set analysis, there is no ready-made and meet the general theory of computable conditions. The advantage of neural network in data mining is: noise data of strong bear ability, high accuracy of data classification, and is available on a variety of algorithms for rule extraction. The neural network is transparent to the users. The application of data mining, neural network model to provide data alone is not enough, the user must understand before important decisions and decision-making basis and reason. Therefore, should establish a professional knowledge base mining BP the algorithm is based on the data mining process to the system to add professional knowledge and neural network to learn the knowledge in the data. Those is to say, in data mining, using knowledge processing method for network establishment for knowledge, and realize the integration of knowledge processing and neural network. In addition, the system should be established a set of effective decision-making mechanisms to improve the interpretation of the data mining technology is effective and practical.

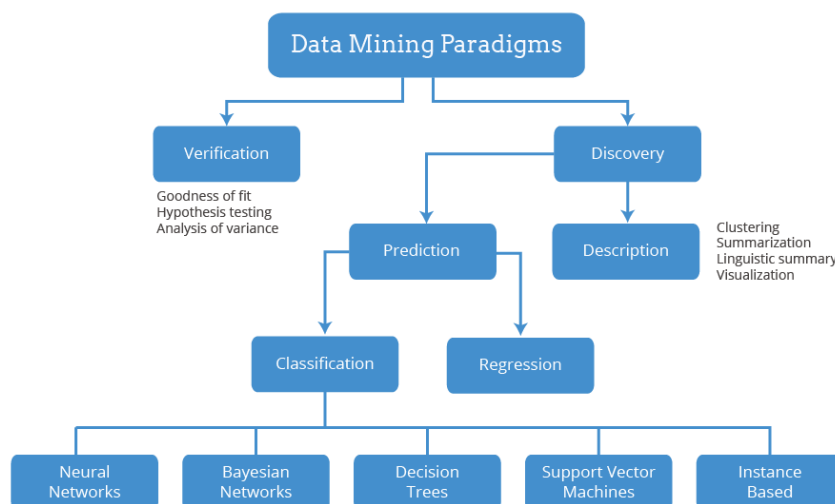


Figure 3. The Data Mining

3. R&D Professionals Based On the Evolution of Independent Innovation

At the present stage, the selection order of independent innovation of Chinese enterprises is the introduction, digestion and absorption, re innovation, integrated innovation and original innovation. Enterprise's technological innovation is a process from the introduction of foreign technology, external introduction and independent development, to the independent development of new technology. Therefore, the evolution of enterprise technology independent innovation stage is mainly through 3 stages, namely, the stage of technology introduction, the integration innovation stage and the original innovation stage. Enterprise independent innovation has the characteristics of gradual and stage, the core technology of independent innovation is derived from the internal long-term technology accumulation after the breakthrough. Therefore, technological innovation organization need have relatively stable R&D personnel resources, to ensure sustainable innovation ability and the improvement of enterprise innovation ability level will put forward the new request to the R&D personnel; on the other hand, because of the characteristics of flat of enterprise technology independent innovation organization structure, self-employment, two-way choice, competition for posts, layoffs dismissal, occupational mobility etc. phenomenon becomes more and more common, therefore the staff tried to through frequent replacement work for career growth. Enterprises on the stability of R&D personnel needs of the organization and R&D personnel career growth highly mobile exclusive, the need to introduce specific organizational context and to optimize based on the combination between the organization contextual characteristics of R&D personnel needs of the organization and career growth. According to the characteristics of each stage of enterprise technological innovation, the organization's ability to R&D personnel is required by the focus on technology application, technology introduction and internal R&D integration to focus on technology independent research and development.

3.1. Learning Requirements Phase

The stage of technology introduction is the initial stage of enterprise technology innovation. Is the characteristics of the stages of technology innovation, practice and marketing enterprises focus on new technologies, due to this innovation behavior is close to the market, complete information fully, the lower the risk. Therefore, in line with the enterprise technology innovation initial investment options. According to the characteristics of the stage of technology introduction, enterprises need to be equipped with a number of innovative potential functional R&D personnel, for the enterprise's technological innovation services. Curiosity and enduring interest in personal creation potential of the most important of the two elements, organizational requirements in the self-directed and incentive value concept under the guidance of, the function of R&D personnel working to explore on technology innovation, and to a higher level of R&D personnel changes. In the stage of technology import and R&D personnel is mostly young, pay more attention to the learning and personal growth, need more enterprises to provide technical practice, research and development opportunities and development environment, focusing more on the perception of enterprises to provide professional growth opportunities, while ignoring the extrinsic rewards and other factors. In this stage, the professional growth of R&D professionals is "learning needs", that is, to acquire new skills and new methods to develop personal ability, and thus to obtain professional growth.

3.2. Stage of Development Demand

With the improvement of enterprise technology level, the technological innovation of the enterprise presents the cascade evolution model, which is the evolution from technology introduction to integration innovation. Integrated innovation is no longer a reference to a single technology, but the integration of existing technologies to create a more competitive emerging products, the essence of integrated innovation is the re integration of production factors. Enterprises' demand for R & D personnel serves the strategic choice of the enterprise innovation stage, therefore, the demand of the original functional talent needs to change to the high efficiency talent demand. Compared with the functional R & D professionals, enterprises require efficient R & D personnel in the aspects of knowledge content and knowledge structure, to better adapt to the requirements of the integrated innovation phase. From the content perspective, efficient R&D people can better accumulate professional knowledge, broaden the research direction, to seek innovative areas, improve the ability of system thinking. Cooperative R&D is a commonly used form of technology integration, which is characterized by the use of R & D personnel skills heterogeneity and complementarity, through the effective integration of the ability to complete the integration of innovation.

R&D professionals through the early career functions to explore, the introduction of technology and the use of foreign technology has a certain grasp, but has not yet reached the original innovation stage. With the arrival of the innovation stage of technology integration, the career development of R&D professionals has also stepped into a new stage. Therefore, in the stage of integrated innovation, efficient R&D personnel career oriented show "demand characteristics, the development oriented individuals to the task itself full of interest, ignore the external return, pay attention to the challenging task and the lifting obtained during the task is completed.

3.3. Technological Innovation Stage

Original innovation is the highest stage of independent innovation, the basic characteristics of the original innovation is the endogenous nature of technological breakthroughs, the first in the technology market competition and the endogenous nature of the support of knowledge. Drucker believes that innovation is creative destruction. The original innovation is to replace the existing market technology with the new technology, to realize the renewal of the technology, and put into the new technology innovation cycle. At this time, the needs of corporate R&D personnel focus is leading R&D personnel, to have the set technology innovation, market development, organizational change and value creation in the R&D personnel to the direction of original innovation and R&D activities play a central role in guiding. This kind of talented person not only needs the technical ability of the functional R&D personnel and the comprehensive ability of the high efficiency type. In the original innovation stage, the technology innovation ability of the leading R&D talent has reached a certain height, is the core strength of enterprise technology research and development. At this stage, the performance of environmental perception satisfaction and self-value is the primary demand of the leading R&D professionals. Therefore, R&D personnel career growth performance oriented out "reveals the features of demand", with highlighting the needs of the individual, existing information or skills as its main purpose. This external adaptation is shown as the orientation and avoidance oriented the former takes the positive external evaluation as the goal, the latter is shown as the sensitivity to risk, which leads to the prudent and conservative behavior decision. In summary, with the gradual evolution of independent innovation, the demand for R&D talents by the enterprise to the R&D personnel is changed from the functional and efficient talents to the leading talent. R&D talent career growth oriented is a learning needs, development needs to highlight the needs of the track.

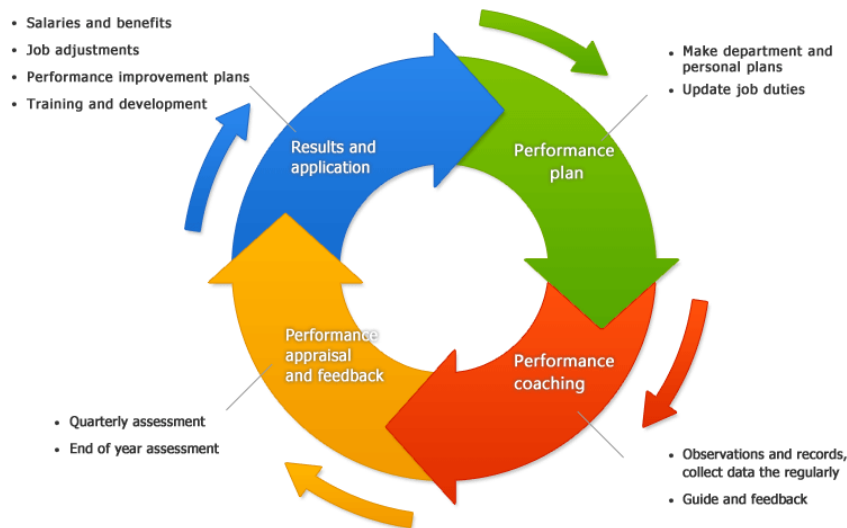


Figure 4. R&D Professional's Career Growth

4. Empirical Analysis

4.1. Evaluation Principle

Evaluation of innovative scientific and technological personnel, is the basis for the work of talent. The research on the theory of innovative scientific and technological talents will be helpful to the establishment of the evaluation system of innovative scientific and technological talents. With the continuous development of human resource management theory and practice, the theory and method of talent evaluation, especially innovative talents evaluation, are constantly improved. In the talent has become the first resource of today, the research and application of innovative technology talent evaluation theory is particularly important. This article will build an innovative scientific and technological personnel evaluation index system for innovative scientific and technological personnel training and leadership to do the theoretical basis. Innovative talents of science and technology is human resources with specific knowledge, skills and expertise and other features, is mainly engaged in scientific research, scientific and technological innovation, the dissemination of knowledge of a high level of intellectual labor, is quality and higher levels of human resources. In general, we have made great contributions to the development of science and technology and the progress of human civilization in natural science and social science and technology. Innovative scientific and technological personnel and the general scientific and technological personnel are distinguished, innovative technology talents in science and technology activities in the outstanding characteristics of the performance are creative and progressive.

A complete evaluation of innovative scientific and technological personnel, the first of course is to determine the basis for the evaluation of the object that is the evaluation index, through the collection of data, to determine the relevant weights, and then evaluation. Through the above all kinds of evaluation methods brief introduction and comparison, considering each method's advantages and disadvantages and limitation of application and adaptability, selected for the index. In this paper, the use of Delphi method, through statistical methods to determine the final evaluation index system; then, in determining the evaluation index system. In this paper, the principal component analysis method and the clustering analysis, obtains the the characteristics of the innovative talents of science

and technology, but also the feature weights determined, and that the comprehensive evaluation conclusion.

4.2. The Evaluation Index

In reference on the basis of previous results, using the methods of literature, with the purpose of innovative talents of science and technology evaluation target is reflected as far as possible characteristic talents, this paper on classification indexes, try to carries on the analysis from the perspective of innate and acquired factors, build by the higher levels of intelligence, knowledge structure, innovation consciousness actively, strong innovation motives, innovative spirit and strong ability of scientific and technological innovation, six aspects constitute the index system of level indicators. The weight of each evaluation index of innovative scientific and technological talents in the whole evaluation index system, from the perspective of the combination of subjective and objective, can be used to determine the weight of the principal component factor analysis method. The principal component factor analysis is through the form of questionnaire survey, but the investigation object is being evaluated in the innovative talents of science and technology, gives to fill their corresponds to the constructed evaluation index system of the evaluation of the content of the corresponding innovative talents of science and technology but this paper selected under a chapter to the evaluation of the case to the target tissue of innovative talents of science and technology as a factor analysis of basic data, and using principal component factor analysis method to get the index weight based on objective data.

Table 1. Evaluation Index System of Innovative Scientific and Technological Personnel

Comprehensive index	First order index	Two level index
Innovative talents	Intelligence level	Observation ,attention thinking structure
	Knowledge structure	Basic knowledge, scientific achievement
	Consciousness of innovation	Curiosity, imagination
	Creative motivation	Sense of achievement, sense of mission
	Creative spirit	Innovation courage, independent consciousness, self-confidence
	Innovation ability	Scientific thinking, learning ability

4.3. Principal Component Factor Analysis

The method of evaluation is of innovative talents of science and technology are investigated by kmo and Bartlett test can be seen that it is suitable to make factor analysis of 14 variables by principal component analysis. The common degree of the variables are all high, so most of the information can be explained by factors.

Table 2. KMO and Bartlett*s Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.64150
Bartlett's Test of Sphericity	Approx. Chi-Square	1269.137
	df	348
	Sig.	1.3E-124

Table 3. Explanatory Variables

component	Initial value			Extract value			Rotation value		
	total	% of Variance	Cum.	total	% of Variance	Cum.	total	% of Variance	Cum.
1	10.142	28.316	28.316	9.301	63.256	24.186	8.124	25.145	22.645
2	9.058	23.146	51.162	3.472	12.131	47.357	8.106	22.131	43.136
3	5.421	11.214	62.376	2.356	6.275	58.252	8.248	21.042	55.428
4	3.876	15.451	77.827	1.681	5.052	76.624	5.637	14.169	75.017
5	2.352	4.665	81.672						
6	1.794	3.242	84.68						
7	1.461	2.587	86.461						
8	1.253	2.064	88.525						
9	1.146	1.925	90.450						
10	.928	1.541	91.991						
11	.764	1.328	93.319						
12	0.512	0.745	94.064						
13	0.405	0.651	94.715						
14	0.337	0.482	95.197						

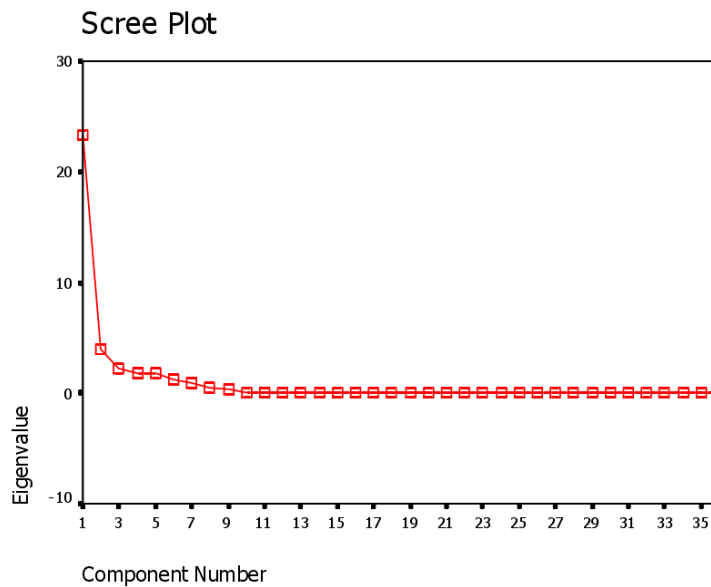


Figure 5. Scree Plot

Through factor analysis, innovative talents of science and technology feature weights, to clear the innovative talents of science and technology occupy the main feature is "the subjective intention of innovation force", that is to say, cultivation of innovative talents of science and technology focus is shaping the subjective intention of innovation force ", and the second is the " scientific and technological innovation ability ", which provide directions for cultivation of innovative talents of science and technology: both must have

the innovation of subjective consciousness and dynamic, should have the corresponding ability. This is exactly what we are currently in practice in the work carried out. And weights of the evaluation indexes and the characteristics of force analysis, can lay the foundation work for the cultivation of innovative talents of science and technology, namely by evaluation found specific innovative talents of science and technology capacity on strength, and then can be clear from what aspects of the education and promotion, which from the theory and Practice of "teaching students in accordance with their aptitude" lay the foundation, in order to cultivate compound talents lay a path based.

5. Conclusions

The technological innovation ability of enterprises with the cascade evolution stages of the innovation and continuous improvement, R&D personnel of professional growth needs are met, for enterprise technology innovation capability improvement and innovation stage evolution provide technical assurance. The balance of supply and demand of enterprise and personal career growth is an important factor to promote the development of organizational technology and staff. The balance between the supply of professional growth and the demand of career growth makes the low level R&D personnel change to a higher stage, which helps to accelerate the evolution of enterprise technology innovation. The former is the enterprise to provide professional development opportunities for employees, can be used to describe the internal environment of their career development; the latter can be used to describe the individual pursuit of their own development achievement motivation. If the organization is not balanced, it will directly affect the organizational loyalty of R&D professionals and lead to talent risk.

With the evolution of the enterprise's independent innovation stage, the demand of R&D personnel is a gradient evolution process from the functional and efficient talents to the leading talent. Accordingly, R&D personnel career oriented also varies with their career development changing, namely learning needs, development needs to highlight the demand. In the process of technological innovation, the career supply of enterprise, which is the support of the organization environment, affects the stability of R&D personnel in the organization. With the evolution of technology innovation and career growth supply imbalance will lead to R&D personnel blindly pursue personal ability to improve, resulting in team in inert, opportunism and innovation stagnation phenomenon, "individual", "group effectiveness" and "innovation" of risk. These risks cannot effectively stimulate the organizational effectiveness of R&D professionals in different periods, and hinder the improvement of enterprise technology innovation ability.

References

- [1] C .Gree and S.Gray, "Human resource management outsourcing the make or buy decision", *Academy of Management Executive*, vol.13, (1999), pp.85-96.
- [2] D.L. Stone and L. Deadrick, "The influence of technology on the future of human resource management", *Human Resource Management Review*, vol.25, no.2, (2015), pp.216-231.
- [3] H. Zafar, "Human resource information systems: Information security concerns for organizations", *Human Resource Management Review*, vol.23, no.1, (2013), pp.105-113.
- [4] A. Nagendra and M. Deshpande, "Human Resource Information Systems (HRIS) in HR Planning and Development in Mid to Large Sized Organizations", *Procedia - Social and Behavioral Sciences*, vol.133, (2014), pp.61-67.
- [5] D.James and R.D.Johnson, "Human resource metrics and decision support: A classification frameworkOriginal", *Human Resource Management Review*, vol.23, no.1, (2013), pp.71-83.
- [6] Z. Hussain and J. Wallace, "The use and impact of human resource information systems on human resource management professionals", *Information & Management*, vol.44, no.1, (2007), pp. 74-89.
- [7] A. Metin and R. Erturgut, "Importance of educated human resources in the information age and view of information society organizations on human", *Procedia-Social and Behavioral Sciences*, vol.2, no.2, (2010), pp.1452-1456.
- [8] S.K. Brian, J.A. McClendon and T.W. Gainey, "Outsourcing HR: The Impact of organizational Characteristics", *Human Resource Management*, vol. 40, (2001), pp.59-63.

Author



QIAN Cheng, (1978.07), Hangzhou, Zhejiang, P.R.China. He has a PhD in Management of Zhejiang Gongshang University, Zhejiang, China. The Associate Professor of Zhejiang Financial College, Zhejiang,China. His research interest fields include human resource management and career management. He published more than 10 papers. He has teaching experience of 10 years, has completed six scientific research projects.