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METHOD RESEARCH ON ESTABLISHMENT OF UNIVERSITY MAJOR WARNING SYSTEM

Tong Li[1,2], Qing Li[2], Rongxia Ma[2], Caisu Du[2] and Hong Zhao[2]

[1]School of Business
Dalian University of Technology
No. 2, Dagong Road, New District of Liaodong Bay, Panjin 124221, P. R. China
litong@dlut.edu.cn

[2]Teaching Affairs Division
Dalian University
No. 10, Xuefu Ave., Dalian 116622, P. R. China

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Abstract. *Control chart is a statistical tool of conducting real-time control for the quality situation as well as an important method in quality control. College major setting under the new situation is social need-oriented, aims to serve social and economic development, and tries to promote employment among students. Scientific major appraisal theories and methods are required to adjust and optimize major structure, and to form an undergraduate major system in accordance with regional economy and social development. This paper applies control chart to quality appraisal for various college majors, and establishes a new major warning system. Using this major warning system, Dalian university has made warning analysis for more than 60 majors for two years. The results are reasonable and satisfactory.*
Keywords: Major warning, Control chart, Major structure optimization, Major appraisal

1. **Introduction.** Major setting of colleges and universities has been adjusted continuously, its comprehensiveness has been enhanced constantly, and the major coverage has been expanded gradually since the beginning of the 1980s. In 1998, Ministry of Education issued *Notification about Strengthening Major Structure Adjustment Force and Relieving Supply and Demand Contradiction of Undergraduates and Specialist College Graduates from Some Majors*, to systemize the existing undergraduate majors of colleges and universities. The new major catalog includes 11 categories which are philosophy, economics, law, education, literature, history, natural science, engineering, agriculture, medical science and management, covering 71 secondary types and 249 majors. Compared with 1980, 790 majors are eliminated in the newly issued major catalog. Number of majors in engineering course reduces from 537 to 70. This was the largest major structure adjustment for common colleges and universities since the nation was founded. In major setting after adjustment, types of majors are reduced, and major foundation and flexible design major direction are expanded. The majors are mainly divided as per the discipline, and different majors possess clear major disciplines or main subjects. In recent years, great changes happened to China's economic structure, especially industrial structure and technological structure. When such changes are reflected in higher education, colleges and universities are required to adjust the major structure according to national economic development trend and social development need. Professional building should be strengthened, new talents suitable for demands of the times must be cultivated, and various measures should be taken to positively guide and promote major structure adjustment and professional building of existing colleges and universities.

Currently, some scholars have conducted certain research on university major warning system. Zhao et al. (2015) studied college Major Early Warning and Exit Mechanism. Focusing on solving the related problems of the major setting of higher education institutions in China, they analyzed the background and the necessity of the major early warning and exit mechanism, and presented the key factors for creating the mechanism [1]. Lu, Wang and Guo (2014) constructed a warning index system of undergraduates' specialties, which included 3 first-level (market needs, employment quality and teaching quality), 10 second-level and 4 third-level indicators [2]. Liu (2013) studied the Characteristic Development of College Specialties Under the Construction of Early-warning Mechanism. The paper presented that the construction and enforcement of the early-warning mechanism can guarantee the characteristic development of college specialties in a healthy and sustainable way [3]. Guan (2012) constructed a major warning system based on college graduates employment status monitoring [4]. Researches and their results mentioned above can offer some reference valuable to this paper.

2. **Analysis on Social Need.** In order to accurately grasp the demand for college talents in the society, we issued 1,334 questionnaires among typical large and medium enterprises in Dalian City, including 1 *Survey Form of Enterprise Talent Demand* and 5 *Questionnaires of Enterprise Talent Demand* filled by Human Resources Department of each enterprise, and 40 *Questionnaires of Enterprise Talent Demand* filled by managers, professionals, skilled workers and undergraduates of each enterprise respectively. 1,281 questionnaires were collected, with the recovery rate of 96%. The investigated enterprises covered productive industries like equipment manufacture, energy and electric power, petrochemical engineering, IT bio-pharmaceuticals and marine fishing as well as service industries like wholesale and retail, real estate development, finance, communication and transportation, and logistics.

2.1. **Demand of enterprises for graduating students.** According to the statistical data about talent demand information of 19 investigated enterprises, the total demand number of enterprises for various talents is 16,660; among them, there are 621 managers, 4,848 professionals, 4,887 skilled workers, and 6,304 graduating students. The demand for graduating students occupies 60.9% of the total demand for managers, professionals and skilled workers. Therefore, graduating students are the main objects for enterprises to absorb talents in the future.

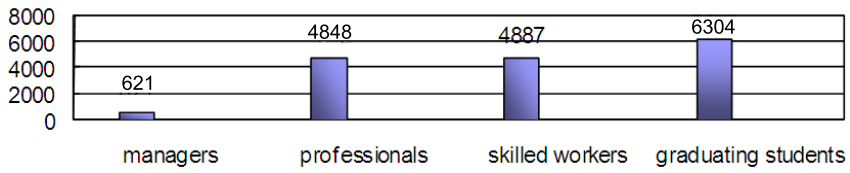

FIGURE 1. Talent demand information of 19 key enterprises in Dalian (unit: person)

2.2. **High-end talent demand.** According to the investigation, now enterprises are in urgent need of senior managers, senior research personnel and senior skilled workers, taking up 92.8% of total talent demand. The proportion of senior skilled workers in total talent demand is the highest, which is 37.36%. Only 2.2% of investigated enterprises treat college and technical secondary school graduates as badly-needed talents. Thereby, top talents play an important role in promotion of great projects and development of key enterprises. They are the important guarantee for smooth implementation of projects as well as sustainable, sound and rapid development of enterprises.

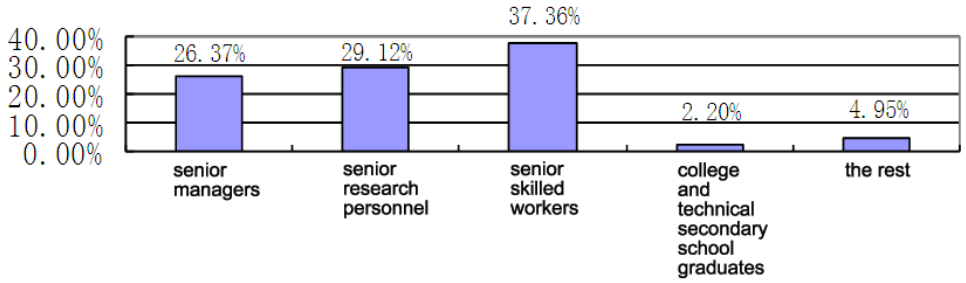

FIGURE 2. Talent in urgent need for enterprises

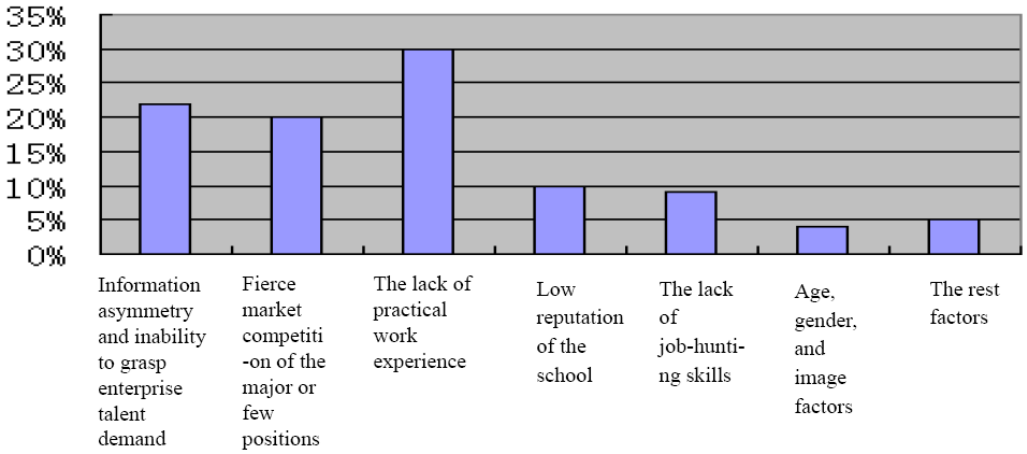

FIGURE 3. Main obstacles in talent employment

2.3. **Main obstacles in talent employment.** In the investigation, only 30% of enterprises will select talents that lack practical work experience. This result is directly related to the fact that most interviewees are graduating students below 30 years old. 22% of interviewees consider that the difficulty during job-seeking process lies in information asymmetry and inability to grasp enterprise talent demand. Moreover, 20% of people consider that fierce market competition of the major or few positions are major reasons for difficult employment. The proportion of people who select low reputation of the school, lack of job-hunting skills, age, gender, and image factors is 10%, 9% and 4% respectively. According to the above results, contradiction still exists between major setting of the school and actual demand of the enterprise; the range and quantity of talent supply and demand information issued on the market are insufficient, so the talents do not understand or seldom grasp talent demand information of the enterprise. This is the major reason of causing talent employment difficulties.

3. **Control Chart of Single-value and Standard Deviation.** Problems reflected from investigations show that universities must make dynamic adjustment to its majors, thus to meet social needs. Control chart is one effective measure to conduct evaluations and early warning for majors. Monodrome-standard deviation control chart is also called monodrome control chart or control chart X, which is characterized with direct use of data without categorizing data. According to applied range of control chart X, employment rate, admission rate of the first choice and unregistered rate are selected to make warning analysis on different majors. We take employment rate as an example and adopt control chart to make analysis (the other two indexes are handled by the same method).

3.1. **Construction of control chart.** Calculate average value $\overline{x}$ and standard deviation S of n years' employment rate $(x_1, x_2, \ldots, x_n)$:

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

$$S = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^2}$$

Get CL (Center Line), UCL (Upper Control Limit) and LCL (Lower Control Limit) on the basis of 3σ theory:

$$\begin{cases} UCL = \bar{x} + 3S \\ CL = \bar{x} \\ LCL = \bar{x} - 3S \end{cases}$$

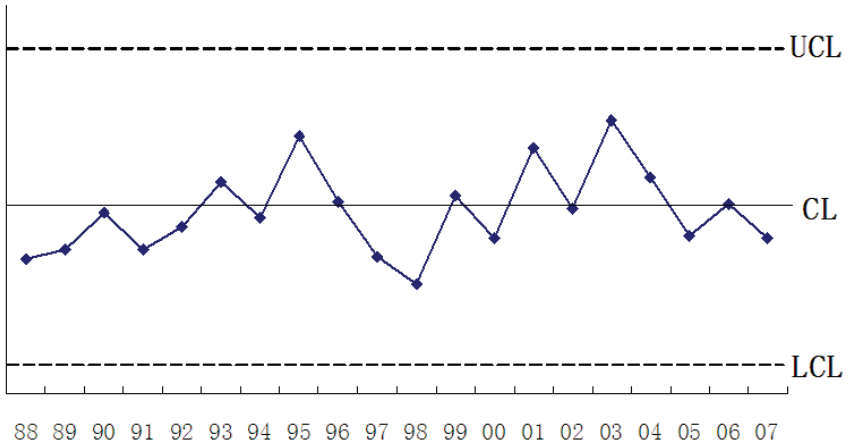

FIGURE 4. Control chart X

3.2. **Analysis and judgments of control chart.**

Controlled state

a) All the values of employment rate are in monitoring limits with no obvious regularity or trend;

b) The numbers of employment rate are almost the same on both sides of CL;

c) Two thirds of employment rate is sited above or under the center line by the range of 1;

d) The closer to control limit, the sparser employment rate is; the closer to center line, the denser employment rate is.

Uncontrolled state

a) 7 consecutive values lie in the same side by center line;

b) At least 10 out of 11 consecutive values lie in the same side by center line;

c) At least 12 out of 14 consecutive values lie in the same side by center line;

d) At least 14 out of 17 consecutive values lie in the same side by center line;

e) At least 16 out of 20 consecutive values lie in the same side by center line;

f) At least 2 out of 3 consecutive values lie in the vicinity of control limit;

g) At least 3 out of 7 consecutive values lie in the vicinity of control limit;

h) At least 4 out of 10 consecutive values lie in the vicinity of control limit;

i) 7 consecutive values on the rise;

j) 7 consecutive values on the decline.

4. **Case Study.** Data of admission rate of the first choice, unregistered rate, employment rate and postgraduate qualifying examination rate are shown in Table 1.

TABLE 1. Data of warning indexes

	2008	2009	2010	2011	2012	2013	2014
admission rate of the first choice	13%	31%	13%	18%	30%	30.20%	30.95%
unregistered rate	15%	7%	0%	3%	0%	4.80%	4.80%
employment rate and postgraduate qualifying examination rate	41.54%	63.33%	60.58%	50.72%	41.83%	30.35%	47.26%

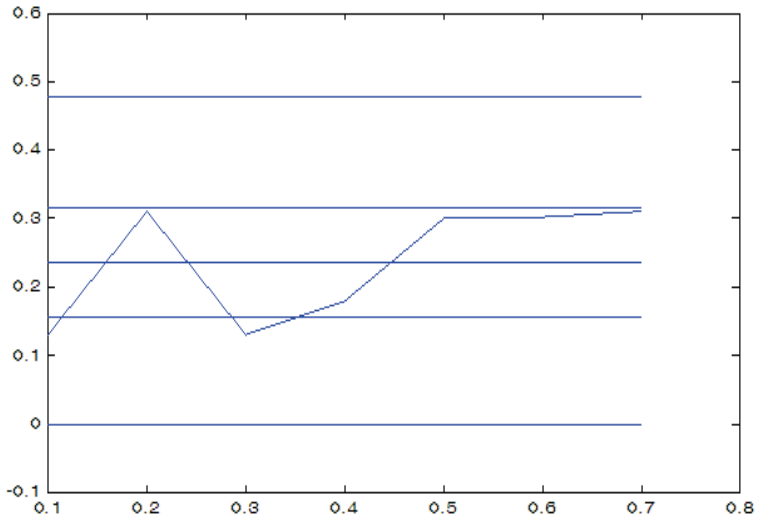

FIGURE 5. Control chart of admission rate of the first choice

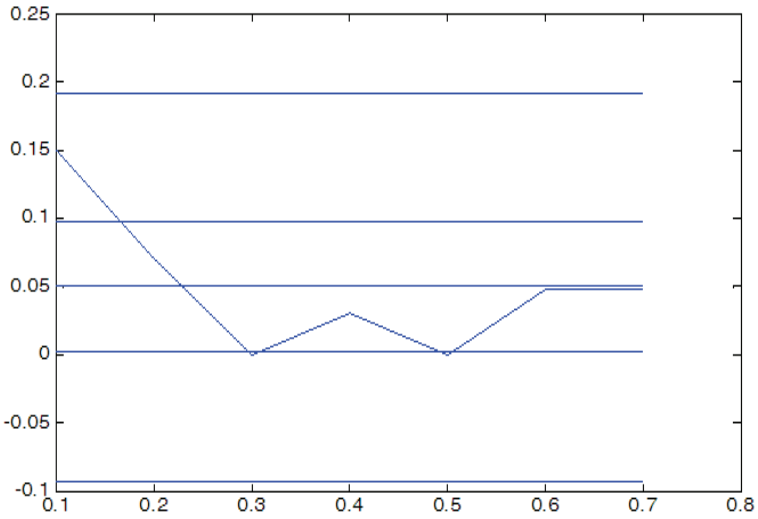

FIGURE 6. Control chart of unregistered rate

4.1. **The control chart of admission rate of the first choice.** According to control chart, all values lie within the control limit, whose permutation is with no obvious law and tendency. The number of employment rate sited on either side of center line is almost the same. Two thirds of employment rate is sited above or under the center line by the range of 1σ. Therefore, the admission rate of the first choice of the major is in the controlled state.

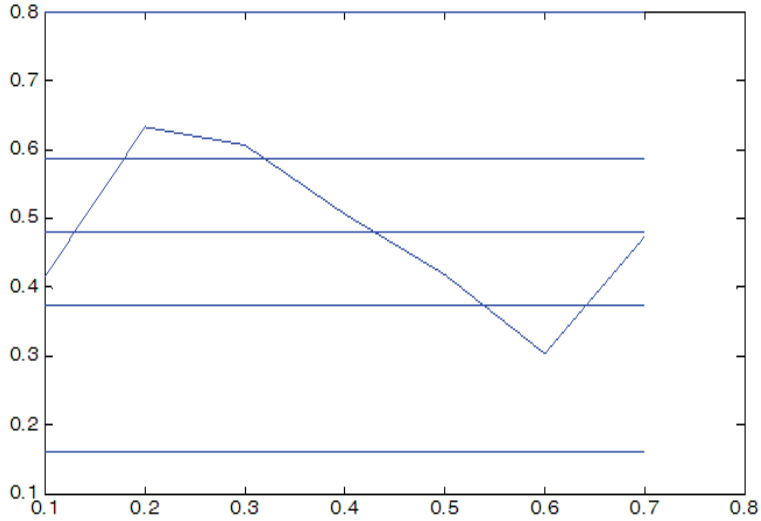

FIGURE 7. Control chart of employment and postgraduate qualifying examination rate

4.2. **The control chart of unregistered rate.** Based on uncontrolled principle of control chart, most values of the chart are under center line. However, considering that the lower the unregistered rate is, the better it is, we can see that the unregistered rate is in the controlled state.

4.3. **The control chart of employment and postgraduate qualifying examination rate.** Among 7 consecutive values, if 5 employment and postgraduate qualifying examination rates are on the decline, it shows that the major is in the uncontrolled state, and thus should be warned.

Using this major warning system, Dalian university has made warning analysis for more than 60 majors for two years. The results obtained are reasonable and satisfactory.

5. **Conclusion.** This paper investigates and analyzes the major structure of current universities, finds graduate employment channels and direction under the new situation, further adjusts and optimizes the professional structure, tries to form the undergraduate major system with obvious advantages, distinctive characteristics, rational layout, structure optimization, and then forms the major adjusting mechanism which is adapted to market demands. This paper applies control chart theory to evaluating different subjects, and gets satisfactory results. This major warning system has received high evaluation from Department of Education of Liaoning Province. Furthermore it establishes the theoretical basis and realistic reference for university's major warning system, graduate employment feedback mechanism and major structure adjusting mechanism.

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