Entrepreneurial competency evaluation of knowledge-intensive teams based on PCA method

Guo Zhao-hui [1,2]

[1]Hengda School of Management,Wuhan University of Science and Technology,

Wuhan, P.R.China

[2]Center for Service Science and Engineering, Wuhan University of Science and

Technology, Wuhan，P.R.China

guozh888@126.com

Abstract. Knowledge-intensive entrepreneurial team is an important driving power to transform scientific and technological innovation into commercial value. The key success factor of knowledge-intensive entrepreneurial team is its competencies. This paper firstly reviewed the literature of knowledge-intensive entrepreneurial teams and competency theory. Secondly, it constructed the knowledge-intensive entrepreneurial team's index system of competency factors. And then, it used principal component analysis (PCA) to evaluate the competence level of 7 knowledge-intensive entrepreneurial teams. Finally, it verified the effectiveness of the evaluation method and drew the conclusion.

1. Introduction

With the deepening development of knowledge economy, the renewal cycle of the products has been shortened greatly. The advanced technology is rapidly improving its emergence in the products.It is a trend that the products are becoming small-scale, multi-varieties and intelligent. In this background, knowledge-intensive entrepreneurial teams have gushed into appearance. This is the realistic requirement of the customers' consumption upgrading, but also the inevitable result of integration of technology and commerce. Knowledge intensive entrepreneurial team refers to a group of two or more members who share the goal of applying high-tech knowledge into products on sale. Despite the growing popularity of knowledge intensive teams, the entrepreneurial process is full of uncertainty, and the overall success rate of entrepreneurship is still relatively low.More and more entrepreneurs have realized that the success of the business depends not only on the knowledge content of the product, but the competence, attitude, motivation and values of the entrepreneurial team, which have an important impact on the achievement of performance.Therefore, the evaluation and management of the competence of the knowledge intensive entrepreneurial team has become a necessary means to reduce the risk of venture and improve the survival rate of the start-ups.

2. Literature review

2.1. Knowledge-intensive entrepreneurial team
The past study reveals that in terms of success rate and performance the team entrepreneurship is better than individual entrepreneurship. Among the entrepreneurship, members should have clear idea of their responsibilities. In other words, the members should be complementary in terms of managerial

skills, decision-making styles as well as experiences. And they have to share an attainable goal based on cooperation. The differences between knowledge-intensive entrepreneurial team and ordinary team lies in the fact that they create and expand their business based on the dynamic application of technological knowledge, and therefore they are under pressure of high risk and uncertainty. They are often confronted with uncertainty of the rules and regulations, market and technology risk. Current research on managing knowledge-intensive entrepreneurial team is still weak.

2.2. Competency evaluation
McClelland (1973) discovered after thorough empirical study that intelligence is not the only factor determining individual working performance but the attitude, character, and cognition. Thomas, etc. (2002) claimed that the entrepreneurship potential of the entrepreneurs mainly include relationship, organization, opportunity, tactics, concept and commitment. Lans, etc.(2011) based on component analysis discovered that core dimensions of entrepreneurial competency are analysis capability, pursuit capability and internet capability. Entrepreneurial competency is defined as the set of characters necessary to achieve excellent performance and is closely connected to the success of the teams' entrepreneurship. In recent years, research on competency evaluation has made significant progress. Different methods such as AHP, Fuzzy comprehensive evaluation, artificial neural network have been widely applied. However, PCA method is rarely used in competency evaluation.

3. Method and procedure

3.1. Samples
A university in Wuhan city of China, in order to encourage and support the students' entrepreneurship, needs to select three teams with greater potential among seven candidates to provide key financial assistance and guidance. As university students entrepreneurial team is typical knowledge-intensive entrepreneurial team with not so clear target market, the competency of the team is the focus of this evaluation. In contrast to the individual competency of the entrepreneurs, the team competency indicators emphasize more on the wholeness, organization and cooperativity. This study selected the seven teams as research samples, numbered from $T①$ to $T⑦$.

3.2. Competency Index
Two university professors studying entrepreneurship and three successful entrepreneurs have been invited to discuss about the required competency factors. A combination of theoretical derivation and focus group interview serves to construct the knowledge-intensive entrepreneurial team competency index system.As is shown in table 1.

Table 1. Knowledge-intensive entrepreneurial team competency index system.

No.	Competency Index	No.	Competency Index
1	Goal compatibility (x_1)	6	Collaboration (x_6)
2	Competition and risk taking spirit (x_2)	7	Resource integration (x_7)
3	Reward and punishment system equity (x_3)	8	Marketing (x_8)
4	Entrepreneurial passion of the team (x_4)	9	Leadership and operational management (x_9)
5	Opportunity recognition capability (x_5)		

3.3. Evaluation Method

9 experts have been invited at the end of 2017 to conduct anonymous and independent grading of the seven entrepreneurial teams according to their report and defence on the scale of 1 to 10. The original data acquired is shown in table 2.

Table 2. Knowledge-intensive entrepreneurial team competency index system.

Competency Index	T ①	T ②	T ③	T ④	T ⑤	T ⑥	T ⑦
Goal compatibility (x_1)	9.00	8.44	9.33	9.22	7.67	8.00	7.78
Competition and risk taking spirit (x_2)	7.44	8.00	7.67	8.11	7.89	7.00	7.56
Reward and punishment system equity (x_3)	8.22	7.22	8.22	7.56	7.11	8.33	8.11
Entrepreneurial passion of the team (x_4)	8.78	9.00	9.11	9.44	7.44	8.22	8.33
Opportunity recognition capability (x_5)	8.44	8.22	7.78	8.78	8.56	8.00	8.11
Collaboration (x_6)	7.89	7.00	8.33	8.22	6.78	8.22	7.44
Resource integration (x_7)	8.33	7.89	8.22	8.44	8.22	7.89	7.78
Marketing (x_8)	7.89	7.67	8.11	8.00	7.33	6.89	7.44
Leadership and operational management (x_9)	7.89	7.56	8.44	8.33	7.44	7.11	7.56

By using PCA based on IBM SPSS Statistic 20, the original data in table 2 is standardized. Thus, the original eigenvalue of the matrix and variance contribution is acquired, shown in table 3.

Table 3. Eigenvalue and variance contribution rate of each variable.

Variable	Original eigenvalue			Loading of sum of squares		
	Total	variance%	accumulation%	Total	variance%	accumulation%
1	4.524	50.263	50.263	4.524	50.263	50.263
2	2.845	31.609	81.872	3.069	31.609	81.872
3	.926	10.240	92.161			
4	.406	4.516	96.677			
5	.168	1.871	98.548			
6	.131	1.452	100.000			

As is shown in table 3, the first two principal components' original data information accounts for as much as 81.872%, with all its eigenvalue higher than 1. Therefore, the first two principal components could be selected to be analyzed. Initial factor loading matrix is as shown in table 4.

Table 4. Initial factor loading matrix and the eigenvectors of principal components.

Principal variable	Initial factor loading matrix		Eigenvectors of principal components	
	1	2	1	2
Goal compatibility (x_1)	0.955	0.220	0.449	0.130
Competition and risk taking spirit (x_2)	0.481	-0.810	0.226	-0.480
Reward and punishment system equity (x_3)	0.058	0.955	0.027	0.566
Entrepreneurial passion of the team (x_4)	0.834	0.207	0.392	0.123
Opportunity recognition capability (x_5)	0.230	-0.735	0.108	-0.436
Collaboration (x_6)	0.530	0.751	0.249	0.445
Resource integration (x_7)	0.750	-0.261	0.353	-0.155
Marketing (x_8)	0.932	-0.110	0.438	-0.065
Leadership and operational management (x_9)	0.958	0.023	0.450	0.014

Thus, the mathematical expressions of the 2 principal components could be established based on their eigenvectors:

- $F_1=0.449C_1+0.226C_2+0.027C_3+0.392C_4+0.108C_5+0.249C_6+0.353C_7+0.438C_8+0.450C_9$
- $F_2=0.130C_1-0.480C_2+0.566C_3+0.123C_4-0.436C_5+0.445C_6-0.155C_7-0.065C_8+0.014C_9$

Based on the variance contribution rate of the 2 principal components, the comprehensive evaluation function could be formed as:

- $F=0.5026F_1+0.3161F_2$

3.4. Evaluation Result

By inputting the standardized original data into the function and the comprehensive evaluation function of the 2 principal components, the score of the 2 principal components and the comprehensive score of the 7 entrepreneurship teams could be obtained, shown in table 5.After ranking them in the ascending order, their comprehensive competence score are as: team③>team④>team①>team⑥>team②>team⑦>team⑤.Therefore, team ③, team ④ and team ① can be given focused support and guidance.

Table 5. Entrepreneurship teams' PCA score and the ranking order.

Entrepreneurship team	T ①	T ②	T ③	T ④	T ⑤	T ⑥	T ⑦
F_1 Score	1.140	-0.384	2.390	2.947	-1.838	-2.462	-1.664
F_2 Score	0.599	-1.319	1.614	-1.066	-2.464	2.168	0.511
F Score	0.762	-0.610	1.711	1.144	-1.703	-0.552	-0.675
Ranking Order	3	5	1	2	7	4	6

4. Conclusion

The knowledge intensive entrepreneurial team is the leading force to promote the transformation and upgrading of the economic structure. Improving the entrepreneurial performance of knowledge intensive teams needs to strengthen the evaluation of team entrepreneurship competency. Principal component analysis (PCA) is a kind of multivariate statistical analysis method with higher objective degree. It can reduce the quantity of competency factor analysis by reducing dimensions, and it does not need to determine the weight of each factor by people. The method of principal component analysis is used to establish the competency assessment model of knowledge intensive entrepreneurial team, and the rationality and reliability of the model is verified through practical application. This calculation result by using this evaluation model is clear and concise. By comparing the difference of the scores of different principal components of different knowledge intensive entrepreneurial team, effective measures could be taken to strengthen the competency development of the knowledge-intensive entrepreneurial teams, and references can be provided for entrepreneurial management decisions.

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