Winter 12-4-2017

Research on the Development of Measurement Scale for The Synergy of College Technological and Creative Team

Chuanhao Fan
Hohai University, China, fanchuanhao@126.com

Ting Wen
Hohai University, China, wen5ting@163.com

Buchao Xu
East China University of Technology, China, bchxu@ecit.cn

Jigan Wang
Hohai University, China, wang_jigan@hhu.edu.cn

Kaiyuan He
Hohai University, China, hky123a@163.com

Fan, C., Wen, T., Xu, B., Wang, J. & He, K. (2017). Research on the development of measurement scale for the synergy of college technological and creative team. In *Proceedings of The 17th International Consortium for Electronic Business* (pp. 222-227). ICEB, Dubai, UAE, December 4-8.

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ABSTRACT

Based on the strictly scale development program and the sorting of existing literature, we used the methods of interview and open questionnaire to collect measurement items for the synergy of college technological and creative team. Next we preliminarily revised measurement items through expert interview, then explored and verified the presurvey scale by using exploratory factor analysis and confirmatory factor analysis. The results show that the measurement scale, consisted of 17 items with good reliability and validity, is constituted of member's identification of team goals, information communication among members, commitment of cooperation, inter-behavior between members.

Keywords: College technological and creative team; synergy; the development of scale

*Corresponding author

INTRODUCTION

In the era of knowledge economy, the global competition is more and more fiercely. As a new form of Industry-University-Research(IUR) organization and a prominent platform for creative talents training, the college technological creative team has become an influential component of the state's scientific and technological innovation systems, as well as plays an important role in the overall development of Chinese scientific research level and the improvement of the national comprehensive strength. Many studies have observed that individual development is a short-term benefit, only through cooperation, information sharing and resources sharing can the team realize the long-term effect of "1+1>2", so as to improve the performance of innovation (Buraj, 2007; C. Annique & Alvaro, 2010; Wu & Su, 2012; Xie *et al*., 2014).

The concept of synergy is a relationship based upon the resources sharing, in which, enterprises are able to realize symbiosis and mutual growth (Ansoff, 1957). Subsequently, Haken established synergetics in 1970's, which mainly reveals the evolution law of system from disorder to order. Soon afterwards, synergetics has been received extensive attention and application. The focus of these studies is the synergistic connotation (Chen & Yang, 2012; Yang *et al*., 2013), coordination mechanism (Li & Liang, 2012; Liang *et al*., 2014), synergistic effect (Sirower,1997; Yun *et al*., 2006) and collaborative optimization management (Wang *et al*., 2012; Wu *et al*., 2013). In recent years, some researchers try to measure the synergy from different methods. Firstly, in 2004, researchers constructed the evaluation of three synergy stages, which contains three dimensions of ideological synergy, behaviour synergy and contingency coordination, with 18 measurement items (Wu *et al*., 2012). Secondly, the synergy ability model was constructed with 23 indexes, which includes six aspects: thinking synergy, knowledge application ability, management ability, interpersonal relationship ability, emergency response ability and innovation ability (Wang & Miao, 2007). Thirdly, a synergy evaluation index was constructed system from three aspects: market capability, scientific and technological innovation ability and team management ability, with 10 secondary indicators and 26 third-class indicators (Lu & Bu, 2010). Fourthly, collaborative evaluation system was constructed, containing 14 indicators from individual, team, organization and inter-organization four levels (Xu, 2010). Lastly, based on the aspects of information, resources, capabilities and Strategies, a synergistic effect evaluation model which contains 9 indicators was constructed (Wang & Zhao, 2013). From overview of the existing research on synergetic measure, it is found that no consensus has yet been formed on the synergy measure. The existing research focus on the industrial level, moreover, in which it mainly focuses on Man and machine, man and system, as well as man and tool. However, it is rarely that researchers pay attention to systematic study of synergy between people, especially to the synergy of college technological and creative team. Hence, this research mainly makes efforts on the exploration of synergy of college technological and creative team, through which, the authors develop a measurement scale to meet the requirement of synergy of college technological and creative team.

Kevin Forsberg pointed out that effective teamwork has four basic principles, which are clearly defining common goals, recognition of mutual dependence on the basis of mutual respect, accepting the shared code of conduct, and sharing rewards and spirit of teamwork and energy. Based on the above principles and the actual situation of college technological creative team, the authors take the synergy of college technological and creative team as a process, and give its definition is that the

team members can communicate fully with each other, trust each other, rely on and agree with each other, promise to abide by academic and team rules, work together and improve team performance, to achieve personal and team success together, on the precondition of recognizing team goals and strategic vision the team members. The synergy of college technological and creative team contains four dimensions: member's identification of team goals, information communication among members, committment of cooperation, inter-behavior between members.

INITIAL MEASUREMENT ITEMS

Based on the analysis of relevant theories, the definition of the main concepts and the support of relevant theories, using the method of literature research, in-depth interviews, open-ended questionnaires and expert interviews, this research developed the initial measurement items for the synergy of college technological and creative team.

Development Approach of Initial Measurement Items

There are four approaches for the development of the initial measurement items. (1) Literature research. In this study, the authors adopted the exhaustive method, listing all the 113extensive literature which contain the concept of synergy, and analysed and summarized these papers, then obtained the key words and research contents. (2) In-depth interviews. In order to ensure the representativeness of interviewees, we balanced and controlled the interviewee's educational background, age, role in the team, work unit, discipline, and working hours. In addition, according to the respondent's working experience and keenly awareness, wel summarized the work motivations which can improve and promote team synergy. Meanwhile, 15 interviewees were conducted by the method of interview and telephone surveys. (3) Open-ended questionnaires. A survey using a questionnaire was conducted among 68 team members in Hohai University, Beijing Institute of Technology and Donghua University of science and technology. Some members among college technological and creative team members were chosen as the survey objects to conduct an open-ended questionnaire survey involved the synergy measure. Finally, the questionnaire recovery rate was 92.65 percent. (4) Expert interviews. In order to analyse the applicability and pertinence of the measurement items more deeply and carefully, this paper adopted Delphi method and forward method, in which 30 experts were invited to participate in the screening of the initial project (The experts include 5 management professors, 8 associate professor of human resources management, 10 PHD students in management, 3 university team managers, 2 university innovation team research backbone and 2 general researchers).

Collation and Classification of The Initial Measurement Items

Through the above approaches, this paper collected the descriptive statements which measured the synergistic of college technological and creative team, and then the items which are overlaps in content and meaning were merged and deleted. Finally, 54 factors were formed. Team synergy indicators mainly involve occupations, societies, schools, individuals, groups, etc., which have greater complementarity, intersectionality and wide coverage. Afterwards, through expert interviews and according to the appropriateness and pertinence of the content, as well as the readability and clarity of the items, we deleted 19 items with controversially, indiscrimination and low universality, merged 15 similar or repeated items. Lastly, 27 project statements were left and converged into 4 categories, Member's identification of team goals(CT), information communication among members(CC), commitment of cooperation(CP) and inter-behaviour between team members(CM), measuring by 12,4,4,7 items respectively (showing as Table 1).

Table 1: Description of measurement items for the synergy of college technological and creative team

Dimension	Measurement indexes	Measurement items	Code
Member's identification of team goals	Goal congruence	Team goals coincide with my individual goals	CT1
	Objective expectation	Team members understand and accept team goals and clearly know their own responsibility in team goals achievement	CT2
	Innovation Consciousness of leader	The team leader who is young, promising and innovative	CT3
	Personnel training	The team can adjust the direction of personnel training according to team's research direction	CT4
	Market prospect	There is promising for the market prospect of team research	CT5
	Innovation discernment	Our team can find innovative projects and start research faster than competitors	CT6
	Feasibility of the goals	Our team and members' goals are moderate, feasible and measurable	CT7
	Stability of goals	Team goals are relatively stable	CT8
	Rules and regulations	There are perfect and sound regulation and strong execution ability	CT9
	Integrate resources	Our team is able to integrate internal and external available resources	CT10
	Talent introduction	Our team with strong vitality often absorbs talented personnel	CT11
	supporting	State and University's policies support creative teams strongly	CT12
Information communication among members	Awareness of communication	Our team members are able to communicate their own innovative experiences and achievements	CC1
	Pre-training	Before the team starts new items, members can get targeted training at the moment	CC2
	Atmosphere of communication	It is harmony between team member who can communicate frankly, and the team have strong research atmosphere	CC3
	Frequency of communication	Our team often provide opportunities for academic exchange in order to supply knowledge updating and integration	CC4
Commitment of cooperation	Affective commitment	I approve team culture and values, willing to do my best and honour for the team	CP1
	Normative commitment	Team members can consciously abide by academic ethics and norms, there is lower cooperation risk	CP2

	Opportunity commitment	I treasure the opportunity and platforms that the team provides	CP3
	Team admittance	There is strict access system for being the member of creative team	CP4
Inter-behaviour between members	Mutual promotion consciousness	Our team members are able to be aware that cooperation and mutual learning can promote "win-win"	CM1
	Knowledge sharing	Team members will share expertise and professional skills with each other	CM2
	Active exchange	Team members are willing to provide to others their expertise and skills which are difficult to learn usually	CM3
	Work efficiency	When working together, members work well and high-efficiency	CM4
	Task coordination	The task configuration between our team members is well coordinated	CM5
	Conflict handling	We see academic arguments as opportunities for knowledge collision, coupling, and learning	CM6
	Tolerating and respecting with each other	Team members can tolerate and respect with each other	CM7

PRELIMINARY TEST AND ANALIYSIS OF THE MEASUREMENT SCALE FOR THE SYNERGY OF COLLEGE TECHNOLOGICAL AND CREATIVE TEAM

Participants

According to the scale composed by the above 27 statements, the Likert 7 orders categorical variable was used, from strongly agree to strongly disagree. The participants are the leader of the college creative team and some members of those teams, they are from Jiangxi University of Finance and Economics, Nanchang University, Donghua Polytechnic University and other 6 Universities, and to whom a total of 260 questionnaires were distributed. Afterwards, 225 questionnaires recovered, which includes 36 ineffective questionnaires. Accordingly, the recovery rate was 86.54 percent, and the effective rate was 72.69 percent. Among the effective questionnaires answers, 64 percent are male, 36 percent female; 30 years of age accounted for 16.4 percent, 31-40 years old 48.7 percent, 41-50 years old 23.8 percent, more than 50 years 11.1 percent; Bachelor degree or below accounted for 1 percent, the master 39.2 percent, PhD 59.8 percent; lecturer and level below accounted for 40.7 percent, associate professor 40.7 percent, professor 18.5 percent; graduate students accounted for 15.3 percent, mainstay of researchers 58.7 percent, team leader 25.9 percent; on the platform side, the national provincial level accounted for 20.6 percent, provincial and ministerial level 79.4 percent.

Reliability Test

To test the reliability and the effectiveness of the questionnaire, we analysed the data by SPSS 17. Since the acquired coefficient of internal consistency was 0.917, greater than 0.9, it indicated that the overall reliability of the questionnaire is well, and that the questionnaire is suitable for the statistical analysis.

Exploratory Factor Analysis

The SPSS output of data presents that the Kaiser-Meyer-Olkin (KMO) statistic is 0.883, greater than 0.8, and the possibility of the Bartlett's Test of Sphericity is 0.000. Accordingly, it illustrates that the items have greater correlation which is considered to be adequate for the factor analysis. Then we adopted the methods of dispersive measures, discrimination analysis and factor analysis to select the measurement items for the synergy of college technological and creative team.

To select the measurement items, we used the methods of dispersive measures by the perspectives of sensitive, judged by the skewness and kurtosis. we deleted the items skewness more than 2 and the kurtosis more then 5: CT3, CT6. Then items were selected through the aspect of discrimination and importance. In discrimination analysis method, if the t-test of one of the measurement items is significant (the value of the sig. less than 0.05), it testifies that this item is able to identify the different samples' reactive degree; if not, delete it. Measurement items CP4 was deleted according to this principle.

Factor analysis uses principal component analysis to extract the component and choose the items that the value of Characteristic root more than 1. Generally speaking, when the cumulative percent of variance more than 60 percent, it testifies that this questionnaire have great constructive validity. From the analysis of Extraction Sums of Squared Loadings, the cumulative percent of variance of the first 4 factors have reached 74.791 percent, and the variance contribute rate of the first factor is 45.103 percent. As a result, it is rational that this paper exacted 4 factors cumulative percent of variance. Referring to the principle of Hair *et al*. (1998), when the simple size is equal to or greater than 50, it can be taken as significant if the factor loading is more than 0.3, it is important if the factor loading was more than 0.4, and it is very important if the factor loading was more than 0.5. In this paper, we regarded 0.5 as the critical point of the factor loading. So, we deleted the measurement items-- CT2, CT4, CT11, CC2, CM4, CM5, CM7--which don't meet the condition. As is shown in the following table 2, we recorded the measurement items based on the score of factor loading.

Table 2: The result of exploratory factor analysis

Dimension	**Measurement items**	**Factor loading**				**Code**
		1	2	3	4	
Member's identification of team goals	Team goals are relatively stable(CT8)	0.848				ct1
	Team goals coincide with my individual goals(CT1)	0.844				ct2
	There is promising for the market prospect of team research (CT5)	0.809				ct3
	There are perfect and sound regulation and strong execution ability(CT9)	0.803				ct4
	Our team and members' goals are moderate, realizable and measurable(CT7)	0.704				ct5
	State and University's policies support creative teams strongly(CT12)	0.691				ct6
	Our team is able to integrate internal and external available resources(CT10)	0.674				ct7
Information	Our team members are able to communicate their own innovative experiences		0.877			cc1

Dimension	Measurement items	Factor loading				Code
		1	2	3	4	
communication among members	and achievements(CC1)					
	Our team often provide opportunities for academic exchange in order to supply knowledge updating and collision (CC4)		0.832			cc2
	It is harmony between team member who can communicate frankly, and the team have strong research atmosphere(CC3)		0.665			cc3
Commitment of cooperation among members	I treasure the opportunity and platforms that the team provides(CP3)			0.778		cp1
	I approve team culture and values, willing to do my best and honour for the team(CP1)			0.725		cp2
	Team members can consciously abide by academic ethics and norms, there is lower cooperation risk(CP2)			0.701		cp3
Inter-behaviour among members	Team members will share expertise and professional skills with each other(CM2)				0.783	cm1
	Our team members are able to be aware that cooperation and mutual learning can promote "win-win"(CM1)				0.717	cm2
	More team members are willing to provide to others their expertise and skills that is usually difficult to learn(CM3)				0.629	cm3
	We see academic arguments as opportunities for knowledge collision, coupling, and learning(CM6)				0.616	cm4

STRUCTURAL VERIFICATION OF SYNERGY OF COLLEGE TECHNOLOGICAL AND CREATIVE TEAM

Participants

In the process of pre-test, the sample was concentrated in Nanchang, Jiangxi Province, and the size was small, however, the process of Confirmatory factor analysis can improve the representative of simple. Using the measurement scale modified through the Exploratory Factor Analysis, a total of 400 questionnaires were distributed to Nanchang University, Donghua Polytechnic University, Hohai University, Southeast University, Wuhan University and other ten colleges and universities nationwide, 377 questionnaires recovered including 351 effective questionnaires.

Among the effective questionnaires answers, 63 percent are male, 37 percent female; 30 years of age accounted for 13.4 percent, 31-40 years old 49.7 percent, 41-50 years old 25.6 percent, more than 50 years 11.3 percent; Bachelor degree or below accounted for 1.3 percent, the master 37.2 percent, PhD 61.5 percent; lecturer and level below accounted for 37.7 percent, associate professor 42.8 percent, professor 19.5 percent; graduate students accounted for 17.3 percent, mainstay of researchers 52.7 percent, team leader 30 percent; on the platform side, the national provincial level accounted for 27.7 percent, provincial and ministerial level 72.3 percent.

Result of Model Testing

Since the model for the synergy of college technological and creative team is an intricate system model, it is difficult to achieve the ideal result through one or two model fitting. Following the principle of from the shallower to the deeper, using the software of Lisre18.8, the author fit the model from single factor index gradually.

Firstly, the two-dimensional simulation fitting verification indicate that the C.R. values of each measurement index are greater than 1.96, passing the significant test, and that the load coefficients are greater than 0.5, all the fitting indexes, χ^2 , df , x^2/df , RMSEA , NFI , TLI and CFI have reached the acceptable range.

Secondly, the three-dimensional simulation fitting verification indicate that C.R. values of each measurement index are greater than 1.96, passing the significant test, and that the load coefficients are greater than 0.5, all the fitting indexes, χ^2 , df , x^2/df , RMSEA, NFI, TLI and CFI have reached the acceptable range.

Lastly the four-dimensional simulation fitting verification was conducted. Subsequently we establish four-dimensional hypothesis model consists of member's identification of team goals, information communication among members, commitment of cooperation among members and Inter-behaviour among members

Table 3: Fitting index table of four-dimensional hypothesis model

Fit indexes	Absolute Fit indexes				Relative fit indexes		
	χ^2	df	x^2/df	RMSEA	NFI	TLI	CFI
Fit result	412.103	113	3.647	0.087	0.9	0.909	0.925

As is shown in Figure 1, the C.R. value of all the measure indexes are more than 1.96, passing the significant test, and that load coefficients are more than 0.5. Between the measurement index of information communication among members and inter-behaviour among members, the covariance is 0.361, the correlation is 0.284 and the value of C.R. is 4.623, passing the significant test; between the commitment of cooperation among members and the inter-behaviour among members, the covariance is 0.608, the correlation is 0.772, and the value of C.R. is 9.501, passing the significant test; between the information communication among members and the commitment of cooperation among members, the covariance is 0.421, the correlation is 0.326, and the value of C.R. is 5.197, passing the significant test; between the member's identification of team goals and the inter-behaviour among members, the covariance is 0.44, the correlation is 0.64, and the value of C.R. is 8.609,

passing the significant test; between the member's identification of team goals and the information communication among members, the covariance is 0.076, the correlation is 0.071, and the value of C.R. is 1.219, passing the significant test, as well as between the member's identification of team goals and the Commitment of cooperation among members, the covariance is 0.427, the correlation is 0.621, and the value of C.R. is 8.393, passing the significant test.

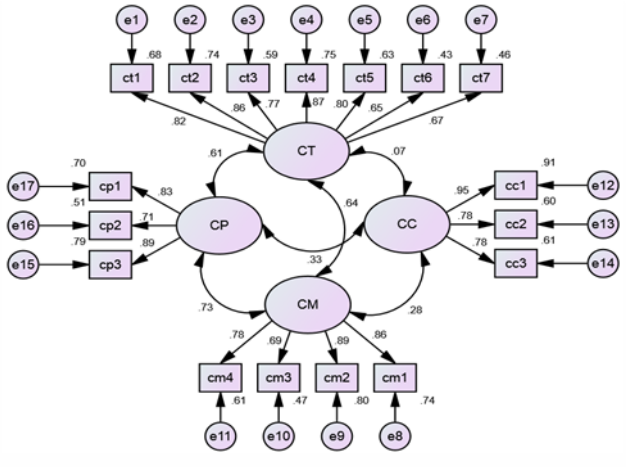

Figure 1: Four-dimensional hypothesis model

CONCLUSION AND DRAWBACK

Conclusion

Firstly, through the literature research, questionnaire survey, interviews and other methods, the components were listed that are relevant to team synergy as more as possible. Secondly, based on the discussion of research and team members, consultant of concerned experts, we analysed and screened the completeness of all original measurement items, the definition of meaning and the accuracy of key words. Lastly, we took repeated preliminary investigation, cleaned up the initial scale, screened the items by the methods of items analysis and obtained the final scale by confirmatory factor analysis. The research shows that synergy of college technological and creative team consists of member's identification of team goals, information communication among members, commitment of cooperation among members and inter-behaviour among members, which belongs to multidimensional construction. In the measurement indexes, firstly, the member's identification of team goals, composed of 7 measurement items, reflects the coincidence degree between the individual research interest and the team goals, feasibility of implementation, and the identification of team management capabilities, market integration skills and school support. Secondly, information communication among members is an important channel for knowledge transfer and diffusion measured by 3 items. Thirdly, commitment of cooperation includes affective commitment, normative commitment and opportunity commitment three measurement items. Lastly, inter-behaviour among members includes mutual promotion consciousness, knowledge sharing, active exchange and conflict handling, four measurement items. Moreover, the measurement scale for the synergy of college technological and creative team have great reliability and validity, which indicate that it is scientific and rational to take the synergy of team as a multidimensional construction.

The college technological and creative team, different from the others, is a vital platform for the people with diverse discipline and major to communicate. In the college platform, it is a vital channel for team members to diffuse knowledge and thinking. However, team trust is the precondition of mutual communication. Only maintaining a harmonious and active research atmosphere, adopting organic communication, cohesion and coordination can the members coordinate well. Accordingly, the result focus more on inter-behaviours between team members, conforming to the reality and trends of modern science and technology developing which need more people to cooperate. Correspondingly, the reality and trends stress more members cooperation, which manifests the significance of the team and necessity of exploring the synergy of team so as to improving the ability of team synergy. All in all, in this research, the dimension of synergy is divided, the connotation is riched and perfected further, and a solid foundation has been laid for the follow-up research of team synergy.

Drawback

´In the study process, the author used scientific and normative interviews method and acquired some findings, however, limited by time, experience, and financial resources, this study still has some drawback. Firstly, the reliability and validity of the scale need further examination. Due to that the research of the synergy of college technological and creative team is at the exploratory stage, there is no mature scale to use. So that, in this paper, we drew on the latest scale and combined the characteristics of the synergy of college technological and creative team to improve the former scale. Meanwhile, limited by sample selection, we just chose the sample from some university in Jiangsu, Jiangxi, Anhui, Beijing, Hubei and other provinces. Nevertheless, the representativeness of samples may be affected, and probably cause bias to the results of the study, even affect the scientific nature of the results. Providing to expand the sample selection range and increase the sample universities in different regions, we could do revalidation analysis of the results of this study. Secondly, the limitation of the research object might affect the result. The subjects of this study are mainly the members of college technological and creative

team, no or less management department participated, especially the participation of the state departments, which may lead to bias in the result of the study. In the future, researchers can add the managers of school science and technology management departments and government related departments as the object of study, so as to make a comparison and repairing of the research conclusions furtherly.

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