

Research on the Construction of Technology Innovation Virtual Team in SMEs:

Based on the Perspective of Industry-university-research Cooperative Innovation

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Abstract: This paper analyzes the necessity and urgency of implementation of industry-university-research cooperative innovation in SMEs, describes the definition and characteristics of virtual teams, demonstrates the building elements of industry-university-research virtual team of SMEs, and proposes the measures for ensuring the construction and normal, efficient operation of the team in the view of government support, system guide and incentive mechanism building by enterprises.

Key words: Technology innovation; Industry-university-research; Cooperative innovation; Virtual team

Today, as the development of knowledge economy, technology competitions become fiercer between enterprises. The innovation capability of a company mostly reflect its competitiveness and sustainable development potential, but because of the weakness of the ability, the SMEs can not complete the design, production, marketing and other technology innovation works alone, besides, the knowledge and information resources is monopoly and asymmetrical. Against this background, enterprises have to strengthen the connection and cooperation between other enterprises, schools and research institutions, especially for SMEs, building a technology innovation virtual team is the key to speeding up development.

1. CO-INNOVATION IS THE INEVITABLE CHOICE FOR SMES TO TECHNOLOGY INNOVATION

Lots of ways can be choice to achieve technology innovation, according to the different implementations, technology innovation can be divided into three categories: original innovation formed by independent R&D, cooperative innovation with different subjects, secondary innovation with the introduction of foreign advanced technology (LIU, DONG, & TIAN, 2006).

Independent innovation is a form of technology innovation usually used by strength large company, in this way, enterprise can get all the profit, without the benefit distribution problem between other enterprises

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and research institute after technology innovation. But, independent innovation have high requirement for technology reserves, technology personnel and other resource conditions, these requirements restrict the enterprises with low level of technology strength to implement independent innovation. However, cooperation innovation with different subjects can use resources effectively, distribute risk, and it can make up the weakness of the capital, technology, knowledge and other field of one enterprise, besides, co-innovation is benefit for the knowledge and technology accumulation of a company. Innovation requires developing individual creativity maximum, requires that members can find their place quickly in a new environment, promote team spirit under the premise of the self-discipline, use all the knowledge to acquire tools, and enrich themselves continuously through the joint study crossed time and space, co-innovation model will be benefit for arousing members' creativity and initiative maximum.

2. INDUSTRY-UNIVERSITY-RESEARCH COMBINATION IS THE EFFECTIVE FORM OF CO-INNOVATION FOR SMES

In co-innovation, "industry-university-research" inactive innovation is one of the important ways to implement technology innovation for the companies lacked of independent technology innovation. The principles of industry-university-research co-innovation are co-existence of interests, risk-sharing, advantages complementary and common development. Under this innovation modal, all the members carry out innovation jointly, in order to achieve a virtuous circle of research-product-market-produce. From the transaction cost theory, cooperative agreement of industry-university-research set that all the partners invest resources together to form a incentive mechanism of mutual mortgage, to force partners regular their own behavior according to the agreement, ultimately to reduce the cost. Co-innovation of industry-university-research not only achieves the share of R&D resources between different organizations, but also saves the transaction cost maximum. Therefore, under the current technological and market environment, industry-university-research co-innovation is a reasonable choice to achieve technology innovation.

At present, a lot of countries and regions are advocating and organizing "industry-university-research combination plan". In some developed countries, like USA, Japan, and Germany, the cooperative research models between company and university are: (1) Enterprises supply capital for research program of universities and research institutions, to cooperate and get results together; (2) Enterprises do cooperative research with universities and research institutions; (3) Enterprises establish laboratory with universities and scientific research institutions jointly, and the laboratory shared with all the partners; (4) University or research institute researchers do research with enterprises researchers on the basis of equality, with the fund supplied by enterprises; (5) Universities or research institutions receive research tasks of enterprises, do "contract research" with enterprises, provide service for the production. Our government also attaches great importance to combination of industry-university-research, main model is enterprise-based and market driven, enterprise-based is determined by their market advantages, such as stronger innovation sense and motivation, more valuable information on market demand, more stable financial resources, and more adventurous entrepreneurs. On the other hand, universities and research institutions have newer and more valuable intellectual capital resources and stronger research capability, the combination of the two parts advantages increase the probabilities of success of technological innovation, accelerate the realization of benefit win-win(SHI, 2007).

3. OVERVIEW OF VIRTUAL TEAMS

3.1 The Concept and Connotation of Virtual Teams

Although domestic and foreign enterprises have paid more and more attention to the co-innovation with university and research institution, in china, the success rate is not high, the main reason can be summarized as: (1) cooperation between enterprises and universities or research institutions is usually in form of contract. Through contract, enterprises profit, university profit and research institution profit can be tied together, thereby the cooperation can be strengthened objectively, but technology contract is imperfection, it can not completely avoid the moral hazard that may exist; (2) In the technology and market activities of

joint development, because of the space and time constraints, enterprises, universities and research institutions usually do their actions alone. University, research institute researchers did not realize the information, knowledge and experience sharing with enterprise marketers truly. Technology, market factors did not become very important variables for technology development, led to the development of technology cooperation is facing huge technological and market risks (ZHANG, 2009).

Management technology of virtual teams makes up the shortcoming of co-innovation under contract form, solves the problem of information does not flow which is caused by time and space, provides method and idea to reduce technological development cost and averse risk. Virtual team is a network organization composed for specific target or project. In perspective of structure, information flow, innovation mechanism, as a kind of network organization and project team, virtual teams break the segmentation of function of the traditional function type organizational structure, show the adaptability to the innovation environment and is the effective organizational form for cooperate development like industry-university-research.

Since the latter half of the 20th century, information technology has rapidly developed and market competition has become fiercer, as a result, traditional business organization form has taken place profound changes. The concept of virtual team has been proposed firstly in the report "21st Century Manufacturing Enterprises Strategy" submitted to congress by a group of American scholars led by Kenneth Preiss in 1991, and triggered a wave of virtualization western business. Intel, Boeing, Nike and some other world famous company have maintained a leading position through successful implementation of virtual management. Virtual organization has generally been considered to be the direction of organization development in 21st century. In general sense, the definition of virtual organization is: A kind of man-machine integration organization supported by informational technology and differently from traditionally organization. Its feature is that virtual organization realizes functions and objects relied on modern communication technology, information storage technology and machine intelligence products. In the form, virtual organization has no fixed geographical space and time limit. The common goal of the team would achieve through members' high self-discipline and common values.

Virtual team is a new management model after virtual enterprise and virtual organization, the construction thought of virtual team is based on dynamic union, virtual enterprise and virtual organization, it is a network-based team that implement specific task of dynamic union, virtual enterprise and virtual organization. Currently, there is no uniform opinion to the definition of virtual team, under the different point to analyze virtual team, scholars have different understanding to the definition of virtual team: Lipnack and Stamps hold that virtual team is a team across time, space and organizational boundaries, and linked by computer network and communicational technology; Martha supposed that anybody contributed to the virtual team tasks should be seen as virtual team member, she defined virtual team from the view of distribution, and called it distributed team which belong to virtual team, as the members in different locations have to interact through computer network and communicational technology; Cascio(2000) considered that the characteristics of virtual team are "members are at different location or from different organization, they communicate mainly through electronic way, and may never communicate face to face, qualification of these members is also not fixed", Cascio mainly focused on the organization of virtual team; Townsend thought "virtual team" is a new organizational structure with assigned tasks, Townsend considered that the team is linked the people and organizations in different locations by network technology (HUA, 2005). In china, research on virtual team started on the late of 20th century, until now most scholars have already form a basic consensus on virtual team, consider that virtual team is a small groups formed cross the distance of time, space and organizational boundaries, it has common goals, and is dynamic, flexible. There are also some other scholars elaborate virtual team from different angles, for example, Yang Changhui and other scholars research virtual team specifically from the perspective of human resources, suggest that virtual team is a virtual portfolio that is human resources cluster-based and common goal-oriented.

I agree with the definition of virtual team made by domestic scholar Wu Qiuming: virtual team is contractual strategic alliance formed by first-class talents who have different knowledge, skills and information, it is task-centered, and its main communicate way is the internet. In the industry-university-research co-innovation, virtual team is business-oriented, and is a team institution that is build between enterprise, university and research with no fixed office space, no time limit, under the encourage and guide of government policies, team works use advantage internet technology to maximize

the limited resources of different organizations, to achieve the share of knowledge resources and win-win situation ultimately.

3.2 Characteristics of Virtual Teams

Virtual team is a new management method, organization model, is different from the traditional linear or linear functional organizational structure, and is the results of modern enterprises adapted to changes of the external environment in new economy. Virtual teams of industry-university-research co-innovation have corresponding characteristics on organizational structure, content and form.

3.2.1 Characteristics on Organizational Structure

Virtual teams beyond generally organizational border, are permeable, fuzziness, flexible and adaptable. Virtual teams are the union formed by members selected from enterprises, universities and research institutions who connect by network communications, any member can be seen as a active node of the network, with the progress of new technology development projects and target completion status, node constitute of virtual teams will change or adjust, to make the development team component by enterprises, universities, research institutions, suppliers and distributors show stronger adaptability to external environment.

From the view of structure elements, members of virtual teams of industry-university-research co-innovation are multiple and complex, except the core technical participants, there are other relevant staff in the relevant work units. Members are from different work environment, there must have large individual differences, among the elements, not only exist information integration, knowledge integration, recourse integration and financial integration, but also have complex principle-agent relationship, trust relationship management, benefit distribution and the relationship between task allocation and coordination, therefore, construction and operation of virtual teams must be affected by subjective factors inevitably, and the affecting process is also complex one.

Virtual teams is information network-based, relying on the network make up the shortcoming of the uneven distribution of innovation knowledge and information, supply a convenient balance channel for the uneven distribution. Virtual teams management integrate and deal with the flow of people, goods, capital, knowledge in the geographically dispersed team members system effectively. Developed information technology enables information flow to support logistics in the team, because of the distribution of business processes, virtual teams members can create basic server and interactive platform to share product, information and service.

3.2.2 Characteristics on Content and Form

The content and form of virtual teams are diversity, virtual form of virtual teams can be divided into function virtual, geographic virtual, organizational virtual, property virtual, management function virtual and technology personal virtual, according to the elements of team organization.

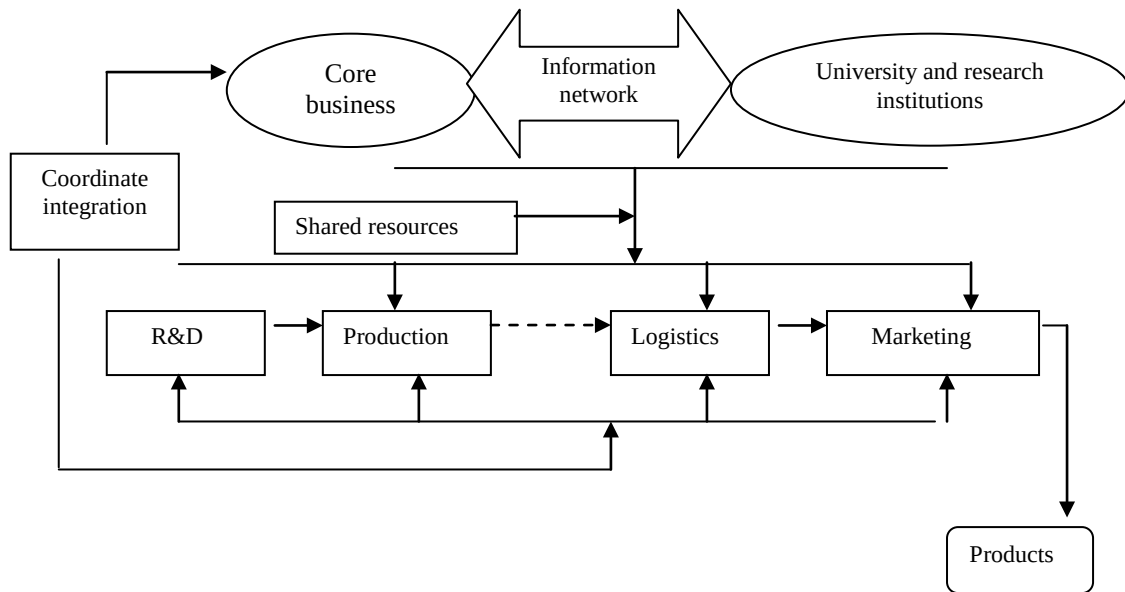
—Function virtual. The members realize the function needed by task through virtual cooperation under organizational form of virtual teams, include scientific research, technology innovation, manufacturing, assembly, market, finance and management, these function are carried out by universities, research institutions and enterprises respectively. Enterprises have the key function to realize marketing objectives, and virtual other important science research and management functions, making up intellectual capital, human resources of universities and research institutions to form enough competitive advantages, and achieve the win-win purpose at the same time.

—Organizational virtual. Unlike the traditional hierarchical structure manufacturing system, virtual teams assemble depended on changes of goal-tasks and environment, organizational structure change from traditional pyramidal structure to flat diversity structure which is better adapted to market competition, overcome the shortcoming of low flexible production and slow market response of the traditional organizational structure.

—Management functions virtual. Virtual team management function separated generally, management service no longer supplied by one main subject, in industry-university-research virtual teams, the subject is still enterprises, and the management service still supplied by enterprises.

—Technology personal virtual. During the development of technology production, technical staffs not only from the enterprises, but also from universities, research institutions and even other cooperative enterprise sectors. This is a strategy of talent gathering.

Generally, virtual team organization is together constituted by core layer and outer layer. Members of core layer are closely connected, more stable, and mainly response for the construction of virtual team, internal coordination, resource integration and strategic decision-making, core layer usually use the federal model, key enterprises play the role of core layer in industry-university-research co-innovation, and make the project, production and market opportunity as the center; virtual teams select appropriate universities and research institutions to form the outer layer, integrating the resources and capabilities together which is needed by the task functions, to form task modules centered by functions, like R&D modules, production modules, logistics modules and marketing modules, these modules cooperate equality, and complete tasks and objectives together (WANG, JIN, 2003). The virtual team organizational structure shown as below:



4. BUILDING ELEMENTS OF VIRTUAL TEAMS IN INDUSTRY-UNIVERSITY-RESEARCH CO-INNOVATION

Through the brief overview of the market competition requirements to technology innovation and meaning and features of virtual teams, we can clear that industry-university-research joint is an important method for SMEs to implement co-innovations and technology innovations, further point out that in order to reduce the limitation of space and time to co-innovation, and under the informational new century environment, virtual team has become an important organization form for industry-university-research co-innovation. To build an effective virtual team, the building elements must be cleared firstly:

4.1 Project Identification, that the Identification and Assessment of Market Opportunities

Not all co-innovation projects are suitable for virtual team to implement technology innovation, if a project have high requirement for continuity and integration, then the virtual team is not suitable; virtual team is also not suitable for these activities which need to share the complex information, like recruitment, trade, innovation and maintain relations. Selections of project should grasp the integration point of advantage of team and market opportunities, from the overall perspective, in the selection of technology innovation projects, factors to be considered of virtual team are roughly the same with generally separate business, mainly include: (1) Team target and strategy, this is guiding principle for virtual team to develop new technology and new product to meet the need of social demand; (2) Market rules, including market status and trends, market capacity, market prices, product life cycle and sale channels, the information in these

regard mainly are responded by enterprises; (3) Financial criteria, including payback period, expected profit value, financial risk and balance funds of project, depend on these information, the possibilities, risks and economy of the project will be clearly shown, and can be used to analysis whether the risk can be avoided by the building of virtual team; (4) Production guidelines, including rational use of production capacity, cost and availability of raw materials, production collaboration within the team and the production arrangement etc. (5) Social benefits guidelines, including environment protection, ecological balance, efficient use of resources etc.

4.2 The Composition of Team Members

Although the network is a communication link for virtual team, the team members are the key of decision-making and project success, the ideal virtual team members should be motivated, and are the staff can work with not a lot of details and work-based instruction. Appropriate members must be good at communication, because their active and clear communication habit can reduce the trouble caused by communication method through cold technology way. However, the staff with poor research abilities, needed to get stimulus from the interaction with others and required additional assistance to state the working orbit, do not fit into the virtual team. If this kind of person is accepted by virtual team, they should be given relevant training about teamwork, planning and communication before joining the team, this situation increase the cost, do not meet the fundamental purpose of virtual team building.

4.3 Leader Determine

Under the conditions of market economy, industry-university-research co-innovation has to choose alliance cooperate model in which the core layer is enterprises, because in the three part of industry-university-research, enterprises do even better in market analysis, and more sensitive to market demand. Only the business-oriented market mechanism can achieve sustained innovation, play the all role of the industry-university-research innovation plat form, and realize the win-win situation of benefits.

4.4 Signing Cooperation Agreements

The last part of building virtual team is signing cooperation agreement, to confirm the rights and obligations of members in legal form, especially in the details like resources investment, risk sharing and benefits distribution, the agreement is system and legal foundation of the effective operation of the team, also related to operational effectiveness of virtual team(WANG, 2007).

5. SAFEGUARDS MEASURES FOR BUILDING VIRTUAL TEAM

5.1 Government Support, Policy Guide

Under the Chinese characteristic government encouragement, the implement of industry-university-research cooperation is to find a way for projects which can not be finished by just one part through promoting the connection of the three parts by the establishment of project funds. At present, most of the technology innovation projects realized through industry-university-research connection are spontaneous, realized through the government organization and coordination is fewer, thus the organizational and coordination function of government have not be full play. So, to ensure good and effective virtual team building, a series of polices corresponded, regulations and corresponding measures should be constructed, and perfect evaluation system of science and technology also should be built to ensure the development of industry-university-research interaction.

5.2 Core Business of Virtual Team Should Create Good Communication Environment for the Team

As the core layer, enterprises of industry-university-research should develop a good operational mechanism, to make sure the smooth and effective information communicate between team members, to create a targeted team atmosphere, to prevent the problems like unclear goals, time dragging of task finishing caused by the virtualization of communication.

Virtual team exchange information through network technology, to some extent, knowledge sharing solves the time and space limitation of information communication, however, communication between members are subject on a certain extent in some areas. To resolve this contradiction, enterprises can take some measures to ease appropriately, such as to establish clear principles and timetable for team communication and carry it out forcibly.

5.3 A Good Incentive System Should be Developed by Original Units the Team Members Belonged to

The flexibility and mobility of virtual team determine the uncertainty of the team members, as the tasks are at different stages, team members will change timely, and this feature will limit the enthusiasm of members. Thus a good incentive system should be developed by original units the team members belonged to, to resolve the members' worryment about their own work. Especially for members from universities and research institutions, as the long scientific research project cycle, researchers may have the trepidation about separating the original position, so the original unions can incorporate the participation in scientific research into the performance assessment, this method not only resolve the worryment of team members, but also can play incentive role.

CONCLUSIONS

6.1 Because of the innovation capabilities limitation of SMEs, and SMEs have more urgent need for technology innovation, building industry-university-research virtual team is the inevitable choice for SMEs. And the rapid development of Internet has provided necessary objective conditions for virtual team, thus objective and subjective have determined the possibility and necessity of virtual teams.

6.2 To build industry-university-research virtual team, SMEs should consider some elements like: Analysis and evaluation of opportunities, membership, leader determine and Signing cooperation agreements, and the enterprises should be the core layer of virtual team.

6.3 Safeguards for building virtual teams can be provided from macro and micro levels. In macroscopic, the government should intensify support, carry out policy guide, and accelerate the cooperation and innovation pace; in microcosmic, as the leader of virtual team, enterprises should set up good operational and incentive mechanism, to promote the efficient operation of virtual team.

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