Literature, Principle and the basics of Network Value Creation in R&D:

The relationship with economy

Nader Ale Ebrahim[1], Shamsuddin Ahmed and Zahari Taha,

Department of Engineering Design and Manufacture,

Faculty of Engineering, University of Malaya, Kuala Lumpur, Malaysia

[1]Phone: +60-17-3942458, Fax: +60-3-7967-5330, Email: aleebrahim@perdana.um.edu.my

Abstract:

The internationalization of R&D network is a recent phenomenon. In this knowledge-based environment, the driving forces for this phenomenon are digitization, the internet, and high-speed data networks that are keys to address many of the operational issues from design to logistics and distribution. From the other direction to surviving in the highly competitive industry, requires strategies to collaborate with or compete with suitable firms within a network in the New Product Development process. The growing internationalization of R&D activities challenges multinational corporations (MNCs) to formulate technology strategies and manage increasingly diffuse and diverse networks of R&D laboratories and alliances in the context of disparate national institutions. Research and development functions are fundamental drivers of value creation in technology-based enterprises. Successful R&D is a function of invention and R&D network. This paper studies R&D network issues from the perspective of their impact on value creation. It is observed that most of the research activities encourage and support R&D networks and influences in economic development.

Introduction:

The mega trends like globalization and high demand fluctuation force companies and supply chains to innovate new business models to gain and maintain competitive position. Networking, outsourcing, and information and communication technology are considered as general tools and means to respond to these challenges (Salmela and Lukka, 2004). As a consequence multinational enterprises have increased their research and development (R&D) investment in foreign countries (Reger, 2004). While the outsourcing activities of the MNCs was highly concentrated in a handful of economies by the beginning of the global R&D wave, the offshore outsourced R&D activities have now been more geographically dispersed and this indeed reveals the increasing value of networking and networks. These multiple sites encourage the development of more ideas, due to the varied international backgrounds in global networks (Richtne´r and Rognes, 2008) taking into account that under the increasingly competitive global

market, a firm simply cannot survive without new products developed under network cooperation, especially for high-tech industries (Chen et al, 2008a).

As another important aspects shedding light on the importance of networking it can be mentioned that since the maximum profit of the network can be obtained by sharing the risk and the benefit with participants, it is important for corporations to collaborate in networks in order to develop capacity, capability and competence to perform new product development and become suppliers of complete systems (Chen *et al*, 2008b). The main advantage of implementing a geographically dispersed R&D network structure is the ability to tap selectively into center of excellence (Criscuolo, 2005). In addition to this such learning networks can generate localized social capital and endogenous growth dynamics (Conceicao and Heitor, 2007).

From a different perspective virtual teams are formed to facilitate transnational innovation processes (Gassmann, and von Zedtwitz, M., 2003) and innovation has a positive impact on corporate performance (Kafouros et al 2008) also a virtual network structure is used to improve communication and coordination, and encourage the mutual sharing of inter-organizational resources and competencies (Chen *et al*, 2008b).To be more exact virtual teams are useful for projects that require cross-functional or cross boundary skilled inputs and the key to their value creation is to have a defined strategy in place to overcome the issues highlighted, especially the time zones and cultural issues .While communication could be seen as a traditional team issue, the problem is magnified by distance, cultural diversity and language or accent difficulties. For migration or similar large-scale projects, personal project management competency, appropriate use of technology and networking ability, willingness for self-management, cultural and interpersonal awareness is fundamentals of a successful virtual team (Lee-Kelley and Sankey, 2008).

In an innovation network resembling a “traditional” organization, the innovation process is more restricted by location and time. In other words, the innovation process mostly takes place within the framework of physical offices and working hours. In virtual organizations, individuals’ work is not restricted by time and place, and communication is strongly facilitated by IT. Such a product development environment allows a greater degree of freedom to individuals involved with the development project (Ojasalo, 2008). Hence multinational companies (MNC) are more likely to become tightly integrated into global R&D network than smaller unit (Boehe, 2007).

(Kafouros et al 2008) found that internationalization enhances a firm’s capacity to improve performance through innovation. Since efficiency, effectiveness and innovation management have different and contradictory natures, it is very difficult to achieve an efficient and innovative network cooperative NPD (Chen et al, 2008a).R&D teams need to access and retrieve information from as many sources as possible. Many innovation strategists argue that a centralized network is required in order to protect corporate technology (Kafouros et al 2008).

Network and economic development:

In recent years, information technology and networks have merged to create companies with characteristics quite different from their production-based counterparts. These include unprecedented market shares, very high returns on invested capital, and rapid growth. As important, the market doesn't always anticipate how the fundamentals of these companies unfold, leading to investable opportunities. Networks channels, railroads, and highways have been around for a long time and played an important role in global economic development. However, our primary interest is not in physical networks but rather in networks that rely on information technology. Economists have successfully described the economics of both information and networks. These economic principles appear durable. It is the combination of information and network properties that creates opportunities for businesses and investors. Most investors have not internalized these ideas. The importance of information-based networks is increasing in today's global economy for four reasons (Mauboussin, 2004):

1. Physical capital needs are lower than they were in the past. Information-based networks require less capital as they grow than physical networks do.

2. Networks demonstrate increasing returns. Most industries benefit from supply-side increasing returns to scale: higher volume leads to lower unit costs, up to a point. In contrast, successful networks generate increasing returns from the demand-side as users beget users.

3. Networks can form faster and more frequently than in the past. Because of plummeting communication and computing costs, the barriers to creating a network are declining. But even though the barriers to entry are low, the barriers to success remain high.

4. Networks can spread globally. Because many networks have high upfront costs and low incremental costs, they can expand rapidly within countries and across borders.

Ethernet inventor Bob Metcalfe formalized network idea mathematically in the 1970s. Metcalfe's Law states that the value (V) of a network increases by the square of its nodes (n). Metcalfe's formula states that $V = n^2 – n$. So a network of ten people has a value of ninety (100 – 10 = 90) but a network twice the size has a value three times higher (400 – 20 = 380). While Metcalfe's fundamental insight is correct, the precise formula has no basis in economic theory and substantially overstates the value of large networks (Metcalfe, 2000) (Rohlfs, 2001) (Mauboussin, 2004).

When you connect computers together, the cost of doing so is n, but the value is n^2, because each of the machines that you hook up gets to talk to all of the other machines on the network. When you graph that, you see that over time your costs go down while the value of the network goes up. Network effects are central to evaluating networks, but we have to bear in mind that the intensity of network effects varies from network-to-network and that network values dissipate at different user-base levels. In networked model companies concentrate on their core business, and in the smooth demand they utilize their own resources and participants can share risks (e.g. investments), which arise from uncertainty of demand (Salmela and Lukka, 2004).

Networks and independency:

Although network companies belong to a network, they are independent. They have for example their own strategies, financial accounting and customer relationships. Furthermore they can belong to other networks, which have their own strategies. Therefore, network rules cannot be too stiff. Companies run their own business, but simultaneously they must agree with network rules.

From traditional industries, construction industry is much networked. New teams are formed for every new project and these teams disperse once the project is complete, thereby, contributing to the fragmentation. Also a construction project itself is a complex activity involving several multi-disciplinary participants. It is a team effort, which involves several inter-organizational activities and dialogues. However, the uptake of electronic commerce in construction has been relatively slow compared to other industries. It is seen that a majority of the industry players are unsure of the exact benefits of electronic commerce applications in construction (Ruikar *et.al*, 2003).

IT and Network:

Information and communication technology (ICT) has brought about significant changes in organizations and produced important benefits, including in the areas of marketing and innovation. Many works highlight the importance of ICT as a key element in integrating marketing into the NPD process (Vilaseca-Requena *et al*, 2007). There has been much of correlation between IT intensity and the creation of networks, the mega trends of information systems are (Hiekkanen, 2003):

1. from technology central to business central;
2. from wide and complex total systems to decentralized small and simple services and applications;
3. from own system to leased system;
4. from proprietary and legacy systems to flexible and networked systems;
5. from customized systems to modulated systems;
6. wireless, mobility and new terminal devices;
7. The role of information system from support process to primary process.

The employed Web Services technology, although very popular nowadays but it is still not mature enough, so dealing with it can bring new findings (Witczynski, 2006). R&D teams need to access and retrieve information from as many sources as possible (Kafouros et al 2008). It seems that the Internet is at least highly complementary to the already powerful trends that are forcing companies to become global, and at most a key driving force of the continued globalization of existing companies (Yip and Dempster, 2005). The internet can facilitate the collaboration of different people who are involved in product development, increase the speed and the quality of new product testing and validation and improve the effectiveness and the efficiency of product development and launch (Sanchez *et al* 2006) also Information and Communication Technology (ICT) enhance the new product development (NPD) which is a results of R&D activities, process by shortening distances and saving on costs and time and makes NPD processes quicker, simpler and less risky (Vilaseca-Requena *et al*, 2007).

Innovation and Network:

Innovation is something new that was introduced in an environment, i.e., a new product, a new way of realizing a process, etc. (Sorli *et al*, 2006) . Therefore, an innovation represents the final stage of a development process, representing the final result achieved and implemented successfully. Innovative activities may relate to new products, new services, new methods of production, opening new markets, new sources of supply, and new ways of organizing. Innovation has been characterized as a process of commercialization of a newly developed product or practice (Dickson and Hadjimanolis, 1998). Innovation correlated with the performance of firms and the new products and process improvements partially account for the higher sales and employment growth as well as the higher profit margins (Dickson and Hadjimanolis, 1998).

(Dickson and Hadjimanolis, 1998) in their study conclude that the more innovative firms, not only in terms of new products introduced in the last 2 years and their relative novelty, but also in terms of process innovation adopted or locally developed, tend to follow proactive innovation strategies, being first-to-market with new products and investing in order to solve problems, increase capacity or upgrade quality of products. Sometimes the production of new products also involves a new production line. The proactive firms usually have a wider variety of technology sources than less innovative firms. As an example that shows the importance of innovation network, imagine you are the first person to own a cell phon. It is effectively worthless because of its inability to communicate with other cell phones. As more people purchase cell phones, the value of your device rises sharply: the larger the network of innovation, the greater the value of the network.

The role of R&D in innovation:

Nowadays unpredictable environment suggests that many firms seek new ways of conducting their business through some kind of innovation to make a profit and stay ahead of the competition (Laforet, 2007).Around the world innovation is now recognized as a prime source of national competitive advantage (Hegde and Hicks, 2008).The principal purpose of business R&D is to develop differentiated products and services to meet the market needs, for technology companies this is core to their survival. Research and development (R&D) and technology as a result of it, have tremendously improved our quality of life over the last five decades. (Von Zedtwitz and Gassmann, 2004).

Research and Development (R&D) is an ongoing process for forward thinking technology-based companies. Development of existing products is advisable to keep ahead of advances that competitors may be making. Further, when a potential customer approaches a firm outlining its requirements for a product, R&D may be required to fulfill the request (Lawson *et al*, 2006).The market success of a company's R&D effort is strongly related to the uniqueness of the product, both in terms of product functions and technical aspects (Kratzer *et al*, 2005). Research is an investment, not an expense, invest in commercial R&D is usually involve a high-risk investment with a deferred payoff although like the other high-risk investments, return can be extremely attractive (Boer, 2005).

R&D units in foreign countries have gained more responsibilities and competencies besides the still-existing traditional mode of adapting products developed in the home country and technical support for production abroad (Reger, 2004).Trends over the last decade have seen

China and India emerge as attractive R&D destinations for U.S.(Hegde and Hicks, 2008).In a recent study, (Li and Yue, 2005) suggested that international research and development processes have two key dimensions: functional focus (either research oriented or development oriented) of R&D activities and geographic dispersion or concentration of R&D sites. These two dimensions lead to four categories of R&D configuration in a host country (Figure 1):

1. Concentrated research and development;
2. Dispersed research and concentrated development;
3. Concentrated research and dispersed development;
4. Dispersed research and development.

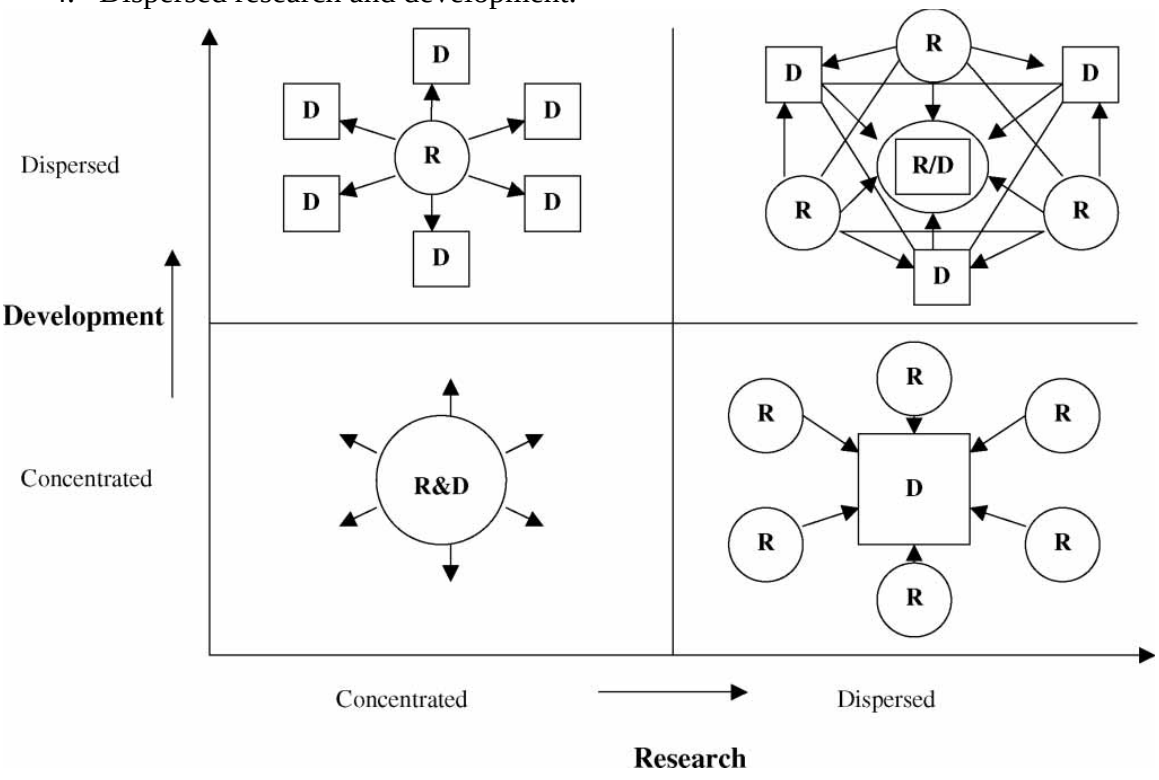

Figure 1: Four categories of R&D configuration in a host country. (Li and Yue, 2005)

Changes in telecommunications and data processing capabilities make it possible to coordinate research, marketing and production operation around the world (Acs and Preston, 1997).(Hegde and Hicks, 2008) noted that overseas R&D sites are auxiliary outposts, subservient to home R&D laboratories. “corporate growth and positioning” and “knowledge sourcing” are two forces which result in companies having a more global R&D (Richtne´r and Rognes, 2008). Technological change is a highly dynamic process that may quickly relocate to take advantage of optimum conditions for growth (Hegde and Hicks, 2008).

Conclusion:

There are different types of networks with varying degrees of network effects. Network businesses offer substantial opportunities for wealth creation and successful networks see sales

grow faster than costs. A network effect exists when the value of a good or service increases as more people use that good or service. In a typical network, the addition of a new customer increases the willingness of all participants to pay for network services. Networking and outsourcing have been increasing especially in rapidly changing industries where demand is difficult to forecast and technology develops fast. Companies pursue to decrease equity in order to maximize return on capital and they focus on business, which adds most value for their customers.

Value added (V) of a network increases by the square of its nodes (n). Metcalfe's formula states that $V = n^2 - n$. From the R&D and innovation perspective, networks can play a very important role in incorporating more creativity in the products and services offered by an enterprise, and as witnessed in the recent trends, the development of networks, virtual teams… has been quite a tremendous trend widely applied by MNCs and TNCs.

To sum up, networking and functioning in a networks is not a choice but an obligation for enterprises these days and most definitely the term "networkization" shall be incorporated within all business operations from sales to marketing, services, recruitment, strategic planning as occurred to R&D and innovation.

References:

1. Acs, Z.J., Preston, L., 1997,"Small and Medium-Sized Enterprises, Technology, and Globalization: Introduction to a Special Issue on Small and Medium-Sized Enterprises in the Global Economy", Small Business Economics, 9: 1–6,
2. Boehe, D. M., 2007, "Product development in MNC subsidiaries: Local linkages and global interdependencies", Journal of International Management, 13,488–512
3. Boer, F.P, 2005,"Research is an investment, not an expense", Applied Catalysis A: General, 280, 3–15
4. Chen, H.H., Lee, A.H.I., Wang, H.Z., Tong,Y., 2008a, "Operating NPD innovatively with different technologies under a variant social environment", Technological Forecasting & Social Change, 75, 385–404
5. Chen, H.H, Kang, Y.K., Xing, X., Lee, A.H.I, Tong, Y., 2008b, "Developing new products with knowledge management methods and process development management in a network", Computers in Industry 59, 242–253
6. Choi, T.Y, 2003, "Korea's Small and Medium-Sized Enterprises: Unsung Heroes or Economic Laggards?", Academy of Management Executive, Vol. 17, No. 2
7. Conceicao, P., Heitor, M.V., 2007, "Diversity and integration of science and technology policies", Technological Forecasting & Social Change, 74, 1–17
8. Criscuolo, P., 2005, "On the road again: Researcher mobility inside the R&D network", Research Policy 34, 1350–1365
9. Dickson, K.E., and Hadjimanolis, A., 1998,"Innovation and networking amongst small manufacturing firms in Cyprus", International Journal of Entrepreneurial Behavior & Research, Vol. 4 No. 1 pp.5-17
10. Gassmann, O., von Zedtwitz, M., 2003, "Trends and determinants of managing virtual R&D teams", R&D Management 33, 3, 243-262
11. Hegde, D., Hicks, D., 2008, "The maturation of global corporate R&D: Evidence from the activity of U.S. foreign subsidiaries", Research Policy 37, 90–406
12. Hiekkanen, K., 2003, "Eliiketoiminta 2004. Teknologiajohtaja, Novo Group." Internet Expo. August, 28th 2003. Helsinki.

13. Kafouros, M.I., Buckley, P.J., Sharp, J.A., Wang, C., 2008, “The role of internationalization in explaining innovation performance”, Technovation, 28, 63–74
14. Kratzer, J., Leenders, R., and Engelen, J.V, 2005, “Keeping Virtual R&D Teams Creative”, Industrial Research Institute, Inc., March-Aprial, 13-16
15. Laforet S., 2007, “Size, strategic, and market orientation affects on innovation”, Journal of Business Research (Article in press), doi:10.1016/j.jbusres.2007.08.002
16. Lawson, C.P., Longhurst, P.J., Ivey, P.C., 2006, “The application of a new research and development project selection model in SMEs”, Technovation , Vol. 26, 2, pp 242-250
17. Lee-Kelley, L., Sankey, T., 2008, “Global virtual teams for value creation and project success: A case study”, International Journal of Project Management 26. 51–62
18. Li, J., and Yue, D.R., 2005, “Managing Global Research and Development in China: Patterns of R&D Configuration and Evolution”, Technology Analysis & Strategic Management, Vol. 17, No. 3, 317–337
19. Mauboussin, M.J., 2004, “Exploring Network Economics”, Available at www.capatcolumbia.com/MM%20LMCM%20reports/Exploring%20Network%20Economics.pdf
20. Metcalfe, B., 2000, “Internet Collapses and Other InfoWorld Punditry”, Foster City, CA: IDG Books Worldwide, 252-253.
21. Ojasalo, J., 2008, “Management of innovation networks: a case study of different approaches “, European Journal of Innovation Management, Vol. 11 No. 1, pp. 51-86
22. Reger, G., 2004, “Coordinating globally dispersed research centers of excellence—the case of Philips Electronics”, Journal of International Management, 10, 51– 76
23. Richtne´r, A., Rognes, J., 2008, “Organizing R&D in a global environment-Increasing dispersed co-operation versus continuous centralization”, European Journal of Innovation Management, Vol. 11 No. 1
24. Rohlfs, H.J., 2001, “Bandwagon Effects in High-Technology Industries”,(Cambridge, MA: MIT Press, 29-30.
25. Ruikar, K., Anumba C.J. and Carrillo, P.M., 2003,” Reengineering construction business processes through electronic commerce”, TQM Magazine, Vol. 15, No 3. pp. 197-212.
26. Salmela, E., Lukka, A., 2004, “Value added logistics in supply and demand chains. Smile. Part 1, e-Business between global company and its local SME supplier network”, Research Report 153, ISBN 951-764-925-8
27. Sanchez, A.M., Perez, M.P., Carnicer, P.D.L., 2006, “Teleworking and new product development”, European Journal of Innovation Management, Vol. 9, No. 2, pp. 202-214
28. Sorli, M., Stokic,D., Gorostiza, A., Campos, A., 2006, “Managing product/process knowledge in the concurrent/simultaneous enterprise environment”, Robotics and Computer-Integrated Manufacturing, 22, 399–408
29. Vilaseca-Requena, J., Torrent-Sellens, J., Jime´nez-Zarco, A.I., 2007, “ICT use in marketing as innovation success factor-Enhancing cooperation in new product development processes”, European Journal of Innovation Management, Vol. 10 No. 2, pp. 268-288
30. Von Zedtwitz, M., Gassmann, O., Boutellier, R., 2004, “Organizing global R&D: challenges and dilemmas”,. Journal of International Management, 10, 21-49.
31. Witczynski, M., 2006, in IFIP International Federation for Information Processing, Volume 224, Networli-Centric Collaboration and Supporting Fireworks, eds. Camarinha-Matos, L., Afsarmanesh, H., Ollus, M., (Boston: Springer), pp. 407-416.
32. Yip, G., Dempster, A., 2005, “Using the Internet to Enhance Global Strategy”, European Management Journal, Vol. 23, No. 1, pp. 1–13