Innovation 2.0 as a Paradigm Shift: Comparative Analysis of Three Innovation Modes

Gang SONG
Institute of RS and GIS
Peking University
Beijing, CHINA
songgangchina@gmail.com

Nan ZHANG, Qingguo MENG
School of Public Policy and Management
Tsinghua University
Beijing, CHINA
{nanzhang, meng}@tsinghua.edu.cn

***Abstract*: The convergence and emergence of modern information and communication technologies opens up new horizons for organizations in a knowledge-based society. Modern ICT transcended the traditional service delivery pattern and innovation pattern by bringing personalized, localized and context aware services close to users. The traditional boundary of organization is dissolving as well as the traditional innovation and R&D boundaries. This paper conducted a preliminary comparative case study of Living Lab, Fab Lab and Application Innovation Park (AIP) based on extended technology-organization-environment framework, and argues the emergence of innovation 2.0 as a paradigm shift from manufacturing paradigm to service paradigm in a knowledge-based society. We need to shift from manufacturing mentality to service mentality and be aware of the potentials of modern ICT on the transformation of the innovation patterns to be more cooperative, open, user-centric and service oriented.**

Keywords: innovation 2.0; knowledge society; technology-organization-environment (TOE) framework; mobility; user-centric

I. INTRODUCTION

The burgeoning growth of new information communication technology (ICT) and its significant contribution to the information society and knowledge-based economy offers strong impetus for social transformation. The informational mode, a new mode of development, has superseded the industrial mode of development. For industrial production, bounded by materials and manufacturing, space is a system of geography and places, while for informational mode of development, space is a continuum of the dissemination of knowledge requisite of the task in the field, despite of its physical location [1], [2]. With the emergence and convergence of ICT, the traditional boundary of organizations and activities is dissolving [3]. The traditional boundary of innovation, a great gap between laboratory research, development (R&D) activities and public or users is also dissolving [4].

In this situation, on one hand, with the support of modern ICT, innovation tend to be carried out where the users or customers are, in their living context, instead of in the offices, factories, laboratories and other fixed locations with their physical settings. The past few decades has witnessed the continuous increase of proportion of service opportunities rather than manufacturing markets. It suggests a profound change from manufacturing to servicing, which let us to reconsider the implications and comprehensions of innovation.

On the other hand, ICT is enabling the co-evolution of knowledge and the pervasiveness of innovation generated by knowledge diffusion and creation. Innovation is ubiquitous: in every firm, in every industry, and in every geography [5]. In industrial economy, government only concerns the allocation of scarce resources; while in a knowledge-based society, the goal is to foster knowledge creation and the innovation. In a knowledge-based economy, governments and some other social forces will be more focused on creating "frameworks" policies that set the new "road-map" for innovative activities [6]. Those types of innovation modes are more nurturing and stimulating drivers for technological innovation.

This paper will discuss and compare three emerging innovation modes from three different regions around the world, Living Lab in Europe, Fab Lab from U.S.A., and Application Innovation Park (AIP) in China. Based on the classical technology-organization-environment (TOE) framework [7], [8], we described the distillations and characteristics of the three modes from those three theoretical perspectives. The comparative analysis and discussion could help us better understand the emerging change of innovation pattern as innovation 2.0 in the knowledge society and the "road-map" of the shift from manufacturing paradigm to service paradigm in innovation process.

II. THEORETICAL FRAMEWORK AND METHODOLOGY

A. Social Topology and Paradigm Shift

ICT plays an increasingly important role in the transformation of our society and organizations and lead to what we call information society, network society, mobile society or knowledge-based society [1], [9]-[11]. The role of ICT in organization has already changed from a mere supportive tool to a major contributor to the form of organizations [12]. With the help of modern ICT, people are not fixed to their office and the place of manufacturing any more. They can organize and coordinate their interactions and exchanges just in time and just in place. Dealing with bureaucratic document in the office was replaced by fluid interaction in the real context and thus improved efficiency of works.

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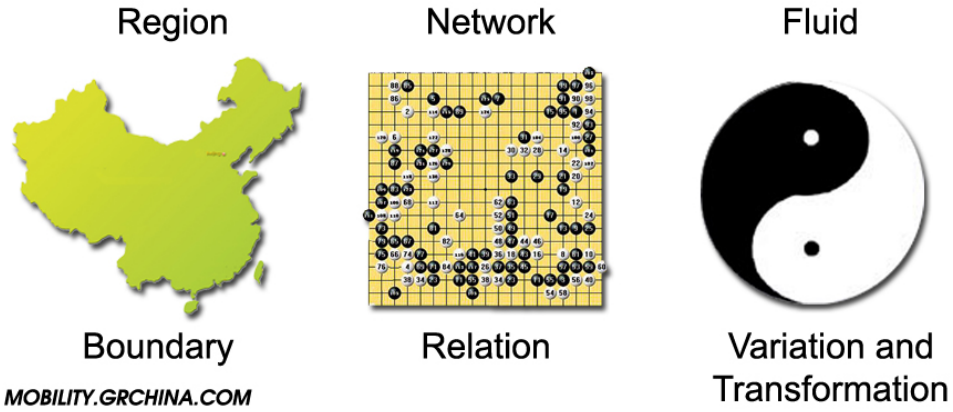

Figure 1: Social Topology [3]

Mol and Law proposed three distinct metaphors of social topologies drawn from their investigation on the spatial properties of anaemia, namely, region, network and fluid [13]. The region is a distinct topology in which objects are clustered together and boundaries are drawn around each region cluster. Therefore, region is characterized by boundary. The network is a topology whereby relative distance is a function of the relationship between components which constitute the network, where complex connection of nodes creates the whole network structure which can be characterized by relationship between the nodes. Fluid is a topology whereby "neither boundaries nor relations mark the difference between one place and another. Instead, sometimes boundaries come and go, allow leakage or disappear altogether, while relations transform themselves without fracture. Sometimes, then, social space behaves like a fluid." A fluid world is exactly the description of Taiji in Chinese culture; it is a world of variation without boundaries and transformation without discontinuity. Therefore we would like to use the boundary of a nation, Weiqi chess, and Taiji (see Figure 1) as metaphors of the three social topologies [3].

The fluid metaphor of mobility in organizational interactions enabled by modern ICT is thus proposed by Kakihara and Sørensen [14]. Dearle argues that, as interaction goes with the users, mobility has been regarded as a new paradigm in computing [15]. Society will be marked by mobile, "Always-on" citizens, government, as well as the transient online communities. Organizations nowadays need to take full advantage of modern ICT as well as dealing with the fluidity of the interaction with the mobile society. By applying a revised organizational change model, Song and Cornford suggest that the transformation of the connectivity and interactions among actors within and outside the organization, thus causing a fluid work practice, and leading to further dissolution of the organizational boundary [3]. From the perspective of complexity science, the traditional science labs and research and development boundaries are also dissolving which leads to the emergence of innovation 2.0 as a new pattern of innovation [4]. Therefore, the paradigm shift from manufacturing paradigm to service paradigm in technology innovation process is ready.

B. Technology-Organization-Environment Framework

To study adoption of general technological innovation, Tornatzky and Fleischer developed the technology-organization-environment (TOE) framework, which identified three aspects of context that influence the process of innovation evolution, adoption, implementation and adaption: organizational context, technological context, and environmental context [8]. In last two decades, TOE is utilized as a basic theoretical framework in many research on innovation evolution and diffusion in one or several business firms [16]-[18].

In this paper, although we will discuss the innovation from a more macroscopical social perspective, the TOE can be extended in the settings for examining and explaining the differences among innovation modes. The extended TOE framework in our study is shown as Figure 2. Technological context is defined in terms of several descriptive measures: degree of modularizing, degree of source open and cooperation level during development, degree of capability on diffusion. Organizational context describes both the static and dynamic relevant factors. This includes size of principal actors of innovation (degree of dissolving of labs boundary, which is the core feature of innovation 2.0), degree of institutional support, and change of innovation diffusion process. Environmental context is the arena in which readiness of testing, change of notion and level of knowledge delivery, and cross countries interaction. Based on this framework, we can describe the distillations and characteristics of innovation 2.0 as innovation paradigm shift from manufacturing to servicing.

C. Methodology

While the cases of Living Lab and Fab Lab are studied through second-hand data analysis, the case study of City Management Applicatioin Innovation Park (AIP) is done by conducting several field interviews to key principals of AIP As an exploratory case study, the research follows a set of classical qualitative research principles in information systems and some other social scientific fields [19], [20].

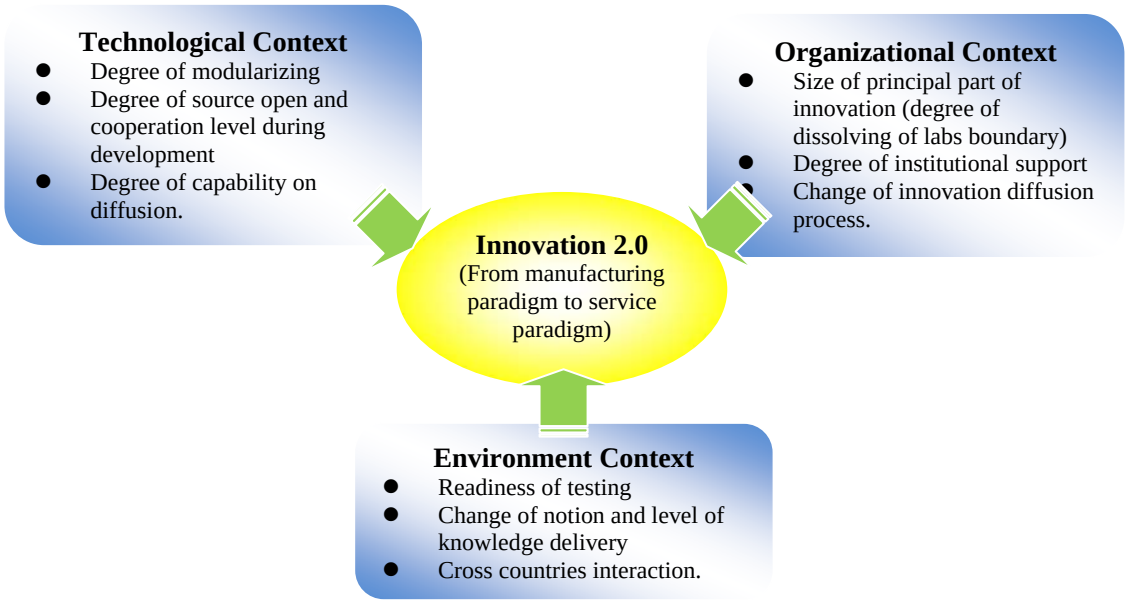

Figure 2: Social Technology-Organization-Environment Framework

III. Comparative Study of Three Modes of Innovative 2.0

ICT Development leads to evolving of knowledge-based society and dissolving of the traditional boundary of laboratory researches and R&D activities. The citizens or the users will be the key players in the innovation process. Focusing on application innovation, featuring user-centric, demand-driven, open innovation and co-innovation, a novel innovation practice which named Innovation 2.0 has emerged in the knowledge-based society [4]. Living Lab, Fab Lab and AIP are three typical modes of innovation 2.0 [21]-[23].

A. Living Lab

Living Lab is a new concept for R&D and innovation to boost the Lisbon strategy in Europe. It is a typical mode of innovation 2.0 which involves user. It is in sharp contrast to the traditional mode, in which products and services are developed by manufacturers in a closed way, the manufacturers using patents, copyrights, and other protections to prevent imitators from free riding on their innovation investments [24]. Living Labs which are full scale urban laboratories for such service development and innovation, are about experimentation and co-creation with real users in real life environments, where users together with researchers, firms and public institutions look together for new solutions, new products, new services or new business models. The city is a natural experimenting ground in which the interests of users, public administrations and business converge with sufficient density. Living Lab is more than experimental facility as its philosophy is to turn users, from being traditionally considered as a problem, into value creation. Living Labs represent a user-centric research methodology for sensing, prototyping, validating and refining complex solutions in multiple and evolving real life contexts. Concludingly, living Lab has aimed to contribute to a new Innovation System where users or citizens are active actors rather than passive receivers [22], [25], [26].

Moreover, the European Network of Living Labs is a bottom up grown organization coming from the European Living Labs, the E.U., national and regional governments, academia and leading companies and small or medium enterprises (SME), providing networking and a global context to its members.

B. Fab Lab

Personal fabrication is the core idea of the Fab Lab concept. Fab Labs are equipped with the tools for every aspect of the technology development process: design, fabrication, testing and debugging, monitoring and analysis, and documentation. And the personal computer as the design tool that is used in conjunction with almost every other tool in the lab. It is used for 2D and 3D mechanical design and modeling, simulations, data analysis, design of various electronic and computational devices, designing and laying out printed circuit boards, programming, interfacing with the fabrication tools, internet access for communication and information retrieval purposes, and documentation. Fabrication tools include two readily available commercial so that can put them out in the field immediately and begin gathering information about their use. One of the tools is the Roland 3D milling and scanning machine and the other is the Roland vinyl cutter. And the standard commercially available software each of these tools can be used for developing the versions of many of these software applications. In order to debug and iterate on a PCB design, some basic electronic equipment was chosen as the testing and instrumentation equipment to be included in every Fab Lab [23], [27]-[29].

In Fab Lab, people can set up a number of fabrication laboratories that are equipped with an initial selection of design and modeling, prototyping and fabrication, testing and monitoring, and documentation tools. A remarkable group of our colleagues – community leaders, educators, and engineers working in different rural communities around the world – are using these tools to develop their own solutions to local problems.

C. The Application Innovation Park (AIP) mode

The Application Innovation Park (AIP) is a kind of institutional arrangement endeavor for user-centric, demand-driven co-innovation, open innovation. AIP for municipal administration in Beijing is the first pilot of this endeavor. It is the important carrier and hub of the regional innovation system, proposed by the government of Beijing, host by the Beijing Science and Technology Association, which involves and serves R&D institutions, business, government at different levels, public service industry and community.

City Management Science and Technology AIP of Beijing is a non-profit innovation platform participated by Beijing Municipal Administration Commission, Beijing Science and Technology Commission, relevant government and public service agencies of 18 districts. From perspective of innovation in public affairs, the collaboration among government, business and society is key to build the socialized, user centric, demand driven, co-innovation and open innovation platform, with 3 "Yan" (TiYan, ShiYan, JianYan), which means experiencing, experimenting, and validation, at its core. TiYan, experience of the user is key to involve the user to make this progress demand-driving. ShiYan, the experiment of the scientist and developer together with the user in their working context will help the innovation suited well for the need of the user. Moreover, validation by third party will secure the quality and value of the innovation or technology for the user and for diffusion of the innovation.

AIP of Beijing start from environment sanitation industry and civic management and will expand to other city management domains while gained more experience in these sectors. City Management Application Innovation Park in Beijing tries to work with all partners to promote user centric & demand driven Application Innovation Mode.

D. Discussions and Comparisons

After conducting meta-analysis of all materials about three innovation modes mentioned above, we have got the comparison table finally (See Table 1). According to the extended TOE framework provided in section 2.2, we listed nine orientations from three contexts for paradigm shift and used "+" to note that the innovation mode has done some efforts on the corresponding orientation.

As shown in this table, the three modes of Innovation 2.0 focus on different perspectives in the TOE framework. While Fab Lab tried to provide more powerful ability of technology development to users (technological context), Living Lab hopes to encourage innovation through build the real life experience environment (environmental context), while AIP pays more attention to institutional arrangement and workflow process design (organizational context). However, we also find that increasing the size of principal part of innovation is the consistent evolving direction for all of three modes. It suggests that dissolving the boundary of labs and other innovation activities and encouraging user-centric and open innovation are the natural requirement and basic method for innovation paradigm shift from manufacturing to servicing.

TABLE I. COMPARISON OF THREE MODES OF INNOVATION 2.0

Model	Living Lab	Fab Lab	AIP
Origin	Europe	U. S.	China
Technological Context			
Degree of modularizing		+	
Degree of source open and cooperation level during development	+	+	
Degree of capability on diffusion		+	+
Organizational Context			
Size of principal part of innovation (Degree of dissolving of labs boundary)	+	+	+
Degree of institutional support			+
Change of innovation diffusion process			+
Environmental Context			
Readiness of testing	+		+
Change of views and level of knowledge delivery	+		+
Cross-countries interaction	+	+	

IV. CONCLUDING REMARK: INNOVATION 2.0 AS PARADIGM SHIFT FROM MANUFACTURING TO SERVICE PARADIGM

In this paper, we provide a view around paradigm shift of innovation based on fluid metaphor proposed by [3], [14]. Then we also discussed the efforts and results of three practical innovation modes of innovation 2.0 based on extended TOE framework. The analysis and conclusion maybe will help to understand the change of innovation activities in modern service industry and other industries in current information age.

Kristoffersen & Ljungberg suggest that a society evolves more through cooperative work instead of bureaucracy [30], [31]; organizations more through service instead of manufacture orientation, and the emergence and convergence of modern ICT contributed to this direction. Since the industrial revolution, most of the work has been carried out in offices, factories, shops, laboratories and other fixed locations, depending on the physical settings and working hours of an organization to coordinate the work in time and space. Spurred by the emergence and convergence of ICT, the rapid development of ubiquitous computing, which is typified by mobile technology, makes it feasible to move work away from the fixed desks and laboratories to support innovation and the service work engaged with the users and customers where they are in their living context.

Innovation means the process of making changes to something established by introducing something new. The goal of innovation is positive change, to serve and create value for users, to make someone or something better. Innovation, leading to increased productivity, is the fundamental source of increasing wealth in an economy. The emergence and convergence of ICT provides people with a more flexible approach to innovation, takes the innovation close to users, allows more integration of innovation services, thus dissolves the traditional boundary of laboratory research and R&D activities, and further pushes the transition of innovation pattern to Innovation 2.0.

Technology innovation, as an emergence out of the complex interaction of the actors and elements of innovation, is an outcome of the double helix structure of technology

development and application innovation [4]. The role of the user and real value creation in innovation can't be neglected any more. It is very important to adopt the service mentality instead of the manufacturing mentality, and to form the user-centric, demand-driven open innovation, co-innovation application innovation platform such as AIP to complement the technology development platform such as high-tech Park. Taking advantage of ICT convergence, Innovation 2.0, which involves the users in a knowledge-based society, will usher in a paradigm shift of innovation from manufacturing paradigm to service paradigm.

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REFERENCES

[1] Castells, M. (1989) *The Informational City*. Blackwell. Oxford.

[2] Rogers, M. (1995). *Diffusion of Innonation (4th. Ed.)* New York: Free Press.

[3] Song, G. and T. Cornford (2006) "Mobile Government: Towards a Service Paradigm" in *the Proceedings of the 2nd International Conference on e-Government*, Pittsburgh, USA. pp. 208-218.

[4] Song, G., Q. Tang, R. Chen and Y. Ji. (2008) "Technology Innovation in Perspective of Complexity Science", *Impact of Science on Society*, 2, pp.28-33.

[5] Romano A. (2003) "Introduction to Digital Innovation" in G. Passiante, V. Elia, T. Massari (eds) "Digital Innovation" Ed. Imperial College Press.

[6] Schwartz P. E. Kelly and N. Boyer. (1999) The emerging global knowledge economy, in The Future of the Global Economy: Towards a Long Boom? OECD, pp. 77-113

[7] Tornatzky, L. G. and K. Klein. (1982) "Innovation characteristics and innovation adoption-implementation: A meta-analysis of findings." *IEEE Transactions on Engineering Management* 29(1) 28–45.

[8] Tornatzky, L. G. and M. Fleischer. (1990) *The Processes of Technological Innovation.* Lexington Books, Lexington, MA.

[9] Giddens, A. (1999). Runaway World: How Globalisation is Reshaping Our Lives. Profile Books, London.

[10] Urry, J. (2000). Sociology beyond Societies: Mobilities for the Twenty-first Century. Routledge, London.

[11] Wang, Z. (2007) "Knowledge Network in Ubiquitous Network Society", *China Journal of Information* Systems, 1(1), 1-7

[12] Malone, T. (1987) "Modeling Coordination in Organizations and Markets," *Management Science*, 33(10): 1317-32.

[13] Mol, A. and J. Law (1994). "Regions, Networks and Fluids: Anaemia and Social Topology.", Social Studies of Science. Vol.24, pp. 641-671.

[14] Kakihara, M. and C. Sørensen (2002). "Mobility: An Extended Perspective." *35th Hawaii International Conference on System Sciences*, Hawaii, USA.

[15] Dearle, A. (1998) "Toward Ubiquitous Environments for Mobile Users". *IEEE Internet Computing*. Vol. 2, no 1, pp. 22–32.

[16] Kuan, K. K. Y. and P. Y. K. Chau (2001). "A perception-based model for EDI adoption in small business using a technology–organization–environment framework." *Information & Management* 38, 507–512.

[17] Zhu, K. and S. Xu. (2003). "Electronic business adoption by European firms: a cross-country assessment of the facilitators and inhibitors." *European Journal of Information Systems*, 12, 251-268.

[18] Zhu, K., Kraemer, K. L. and Xu, S. (2006). "The Process of Innovation Assimilation by Firms in Different Countries: A Technology Diffusion Perspective on E-Business." *Management Science*, 52(10), 1557-1574.

[19] Yin, R. K. (2003). *Case Study Research Design and Methods (3rd Ed.)*, Sage Publications, Thousand Oaks.

[20] Yin, R. K. (2003). Application of Case Study Research (2nd Ed.), Sage Publications, Thousand Oaks.

[21] Song, G., L. Li and W. Wang. (2008b) "Practice of City Management "3 Yan" Application Innovation Park Mode" Chinese Public Administration, 2008(s), pp.98-101.

[22] Song, G., Y. Ji, Q. Tang and N. Zhang. (2008c) "Innovation Mode of Living Lab and Its Enlightenment" Scientific Management Research, 62(3), pp.4-7.

[23] Song, G., K. Chen, N. Zhang, Q. Tang and H. Zhu. (2008d) "Innovation Mode of Fab Lab and Its Enlightenment" *Scientific Management Research*, 62(6), pp.1-4

[24] Hippel, E. (2005). *Democratizing Innovation*. Cambridge, MA, 2005

[25] Leon, M., M. Eriksson, S. Balasubramaniam and W. Donnelly. (2006). "Creating a distributed mobile networking testbed environment - through the Living Labs approach" //Proceedings of 2nd International IEEE/Create-Net Conference on Testbeds and Research Infrastructures for the Development of Networks and Communities (TridentCom), Barcelona, Spain.

[26] Oliveira, A., Fradinho E, CairesR, etc. (2006) "From a Successful Regional Information Society Strategy to an Advanced Living Lab in Mobile Technologies and Services"//Proceedings of the 39th Hawaii International Conference on System Sciences, US.

[27] Mikhak, B., C. Leon and T. Gonton, Gershenfeld N, McEnnis C and Taylor J. (2002). Fab Lab: An Alternative Model for ICT Development.

[28] Gershenfeld, N. (2005). FAB: The Coming Revolution on Your Desktop--From Personal Computers to Personal Fabrication. New York, 2005, 4.

[29] Mandavilli, A. (2006). "Appropriate Technology: Make Anything Anywhere." *Nature*, 2006, 442, 862-864.

[30] Kristoffersen, S. and F. Ljungberg. (1999) "Mobile use of IT", In the *Proceedings of IRIS22*, Jyväskylä, Finland

[31] Kristoffersen, S. and F. Ljungberg. (2000). "Mobility: From stationary to mobile work." *Planet Internet*. K. Braa, C. Sørensen and B. Dahlbom. Lund, Sweden, Studentliteratur**:** 41-64.

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