SUSTAINABLE ENTREPRENEURSHIP PROJECT

Technology Management: A Global Survey of Theory and Research

SUSTAINABLE ENTREPRENEURSHIP PROJECT
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About the Project

The Sustainable Entrepreneurship Project (www.seproject.org) engages in and promotes research, education and training activities relating to entrepreneurial ventures launched with the aspiration to create sustainable enterprises that achieve significant growth in scale and value creation through the development of innovative products or services which form the basis for a successful international business. In furtherance of its mission the Project is involved in the preparation and distribution of Libraries of Resources for Sustainable Entrepreneurs covering Entrepreneurship, Leadership, Management, Organizational Design, Organizational Culture, Strategic Planning, Governance, Corpoorate Social Responsibility, Compliance and Risk Management, Finance, Human Resources, Product Development and Commercialization, Technology Management, Globalization, and Managing Growth and Change.

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Technology Management:
A Library of Resources for Sustainable Entrepreneurs
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The Sustainable Entrepreneurship Project (www.seproject.org) also prepares and distributes other Libraries of Resources for Sustainable Entrepreneurs covering Entrepreneurship, Management, Organizational Design, Organizational Culture, Strategic Planning, Governance, Corporate Social Responsibility, Compliance and Risk Management, Finance, Human Resources, Product Development and Commercialization, Technology Management, Globalization, and Managing Growth and Change.

§1:1 Introduction

From the very time they are launched, companies need to engage in a careful and deliberate process of developing, implementing and continuously improving policies and practices with respect to development, acquisition and protection of the technology and other intellectual property rights that are necessary for pursuit and achievement of their strategic goals and objectives. In general, technology management concerns itself with the creation or acquisition of technology, particularly the process of transforming basic knowledge, or science, into products that have practical and commercial utility in the marketplace or in internal business activities. Technology management also includes the steps that need to be taken to protect the technology of the firm, including the development and maintenance of an intellectual property rights portfolio, and the formulation and implementation of strategies for commercial exploitation of the company's technological assets.[1]

The importance of comparative research relating to technology management has increased as technology itself has emerged as one of the principal factors of production and innovation in business organizations all around the world. As companies, even small firms, have continuously expanded their worldwide operations and established business activities in multiple countries, often widely dispersed in terms of time and distance, they have become necessarily become dependent on acquiring and using the technology that is needed in order for them to coordinate activities across borders and facilitate communication within their global networks of offices, branches and subsidiaries. Globalization has also focused attention on the skills and processes that organizations must develop in order to transfer and diffuse technologies across national borders. In addition, of course, senior management, as well as other personnel involved in new product development activities, must continuously scan domestic and foreign markets to identify technological trends and seize opportunities to gain access to new technologies that can be integrated into products and deployed to improve productivity. Finally, technology management is relevant to national policymakers interested in making investments in technologies that will enhance the competitiveness of entire countries and improve the economic and social welfare of their citizens.

An array of empirical evidence has been collected and used to develop various theories regarding the diffusion and adoption of new technologies or innovations.[2] For example, politics and governmental policies, particularly the political structure that is in place a particular country, appear to play an important role in the diffusion of modern communications technologies in that country. It has been suggested that countries in which an authoritarian government is in place are less hospitable to new technologies that might facilitate interpersonal communications such as telephones and the Internet and that governments in those countries can be expected to invest fewer resources in

[1] For further discussion of technology management, see "Technology Management: A Library of Resources for Sustainable Entrepreneurs" prepared and distributed by the Sustainable Entrepreneurship Project (www.seproject.org).

[2] N. Kshetri, N. Dholakia and R. Dholakia, "Global Diffusion of the Internet", in H. Bidgoli (Ed.), The Handbook of Technology Management (2010), 585, 595-596.

developing the infrastructure needed for these communications technologies to flourish.[3] This suggestion, if true, can explain why the growth of the Internet has been hampered and slowed in countries such as China, Cuba and Syria where the entrenched authoritarian governments have often taken extreme measures to block information that is available to citizens and the ability of citizens to communicate with one another and with persons outside of the country. Theories from sociologists have been used to argue that "Western control of mass media" has been used to drive consumer demand for new technologies in developing countries where citizens have become fixated on imitating what they see happening in the developed world.[4] Other research disciplines have added their own perspectives on diffusion and adoption of new technologies: differences in societal culture explain why particular technologies are more comparable with certain societies than others[5]; understanding of, and experience with, elements of information systems (i.e., people, hardware, software, communications networks and data resources) influence the rate of diffusion and adoption[6]; and diffusion and adoption is heavily dependent on economic, geographic and geopolitical factors, particularly income levels and characteristics of populations (i.e., skills, educational qualifications, literacy rates, productivity and the cost of labor) [7].

As globalization continues and accelerates researchers have shown increasing interest in understanding how technologies emerge, develop, move outward across borders and adapt themselves to unique local conditions within each country. Inquiries on these issues have focused researchers on the role of national culture in the management of technological change. Arguments for the relevance of societal culture to technological change emphasize that individuals and technologies are embedded in a social context that is heavily influenced by national culture and ideology and that societal culture determines the beliefs, practices and perceptions that individuals from that society bring to their decisions regarding the creation, adoption and use of new technologies. An important byproduct of these arguments is that each society interacts with technologies differently. In other words, "[t]he innovation, adoption, and use of technology is . . . 'an inherently cultural process whereby the same technology has the potential to be constructed in

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[3] Id. at 595 (citing A. Groth and W. Hunt, "Marxist-Leninist Communications Systems in Comparative Prospective", Coexistence, 22(1985), 123; N. Kshetri, "Determinants of the Locus of Global E-Commerce", Electronic Markets, 11(4) (2001), 250; and N. Kshetri and N. Dholakia, Impact of Cultural and Political Factors on the Adoption of Digital Signatures in Asia (2001)).

[4] N. Kshetri, N. Dholakia and R. Dholakia, "Global Diffusion of the Internet", in H. Bidgoli (Ed.), The Handbook of Technology Management (2010), 585, 595.

[5] N. Kshetri and N. Dholakia, "Determinants of the Global Diffusion of B2B E-Commerce", Electronic Markets, 12(2) (2002), 120, and S. Zaheer and A. Zaheer, "Country Effects on Information Seeking in Global Electronic Networks", Journal of International Business Studies, 28(1) (1997), 77.

[6] J. O'Brien, Introduction to Information Systems (8th Ed.) (1996).

[7] N. Kshetri, N. Dholakia and R. Dholakia, "Global Diffusion of the Internet", in H. Bidgoli (Ed.), The Handbook of Technology Management (2010), 585, 595 (citing S. As-Saber, P. Liesch and P. Dowling, Geopolitics and Its Impacts on International Business Decisions: A Framework for a Geopolitical Paradigm of International Business (2000); S. Cohen, Geography and Politics in a World Divided (1963); and T. Baerwald, "Geographical Perspectives on International Business", in M. Czinkota, I. Ronkainen and M. Moffett (Eds.), International Business (4th Ed.) (1996).

radically different ways across diverse cultures'".[8] Potential differences between countries with respect to technological change attributable to variations in societal cultures have been explored by several research themes including work on national innovation systems, the influence of societal culture on cross-border technology transfers and differences among countries with respect to adoption and use of information and communications technologies.[9]

The concept of a "national innovation system" was developed in an effort by researchers to identify and explain the factors that influence the technology performance of nations. According to Nelson, a national innovation system can be understood as a set of institutions and institutional actors within the nation that, through their interactions, determine the innovative performance of national firms.[10] Researchers interested in national innovation systems argued that there were differences between countries with respect to the configuration and performance of their systems and sought to understand why those differences existed, including how and why the systems developed the way they did, and how changes might be made in those systems to improve overall technological performance.[11] Among other things, researchers attempted to establish universal benchmarks and "best practices" that could be used as reference points for nations interested in making changes to their innovation systems.

Aten and Nardon commented that research work relating to national innovation systems has had a significant influence on policymakers, particularly in the way that it has encouraged the replacement of traditional linear models of innovation with a "systems perspective" that acknowledged the interdependence of institutions, firms and agents in carrying out innovative activities. They also noted that even though technological research activities have become more and more globalized studies have confirmed that innovation systems do differ across countries and that institutions do have a significant influence on the performance of these systems. However, Aten and Nardon observed that while researchers interested in the study of national innovation systems have routinely argued that such systems are significantly influenced by societal culture the reality is that the actual research work has generally failed to explicitly address the role of culture and when culture has been taken into account it "serves only as a background, homogenous and stable context".[12]

Tylecote et al. compared the role of financial systems and societal culture to technology styles in Japan and the UK by relying on two of the dimensions of societal culture from the Hofstede model—power distance and individualism/collectivism—to create a distinction between two cultural types—"bourgeois" and "aristocratized"—that was

[8] K. Aten and L. Nardon, "International Technology Management and National Culture", in H. Bidgoli (Ed.), The Handbook of Technology Management (2010), 757.
[9] Id. at 758-760.
[10] R. Nelson, "National Innovation Systems: A Retrospective on a Study", Industrial & Corporate Change, 1(2) (1992), 347.
[11] K. Aten and L. Nardon, "International Technology Management and National Culture", in H. Bidgoli (Ed.), The Handbook of Technology Management (2010), 757, 758.
[12] Id. at 759.

based on attitudes about social position.[13] Japan was presented as an example of a bourgeois country while the UK was identified as aristocratized. Tylecote et al. argued that production managers in bourgeois countries were more involved in the innovation process, accorded higher status, awarded higher pay and provided with more training than their counterparts in aristocratized countries. The position of production managers in aristocratized countries was determined in a hierarchical manner consistent with the widely held beliefs in societal culture and it was therefore not surprising to find that they had a much lower social position in their countries than their counterparts in the bourgeois countries. Tylecote et al. went on to assert that societal culture influenced a country's preferred "style of innovation" and that the style determined which industries were best suited for exploitation by firms in that country. For example, they argued that engineering and steel production was the best fit for Japan while the UK should devote its efforts to fine chemicals and pharmaceuticals.

Lee and Ungson studied certain factors associated with Korea's relatively rapid adoption of the Internet and its associated technologies.[14] They noted that two factors—the application of new technologies and an emerging pattern of individual consumption—could be applicable to any technological environment; however, a third factor, which they described as a supporting logic of enterprise that linked the first two factors, was in their view linked to unique Korean cultural values and institutions including rule orientation, high power distance, harmony and affection and monochromic time orientation. Further support for the role of societal culture in technology adoption is provided by the findings of Nardon and Aten that "the wide-spread adoption of ethanol in Brazil is . . . explained by a culture-influenced strategy of flexible adaptation to changing fuel needs".[15]

International technology transfer—the transfer of technologies across national borders and the absorption and use of those technologies once the transfer process has commenced—has become a focal point of globalization of business activities and thus has attracted the interest of researchers from a variety of disciplines who have looked at technology transfer at several different levels. For example, researchers have analyzed the economic and technological aspects of technology transfer at the national level including steps that governments have taken to regulate inbound technology transfers in the context of foreign investment activities. At the firm level, researchers have focused on a variety of factors that are considered likely to have an influence on how technology is transferred, received and used including organizational factors (e.g., goal alignment, local managerial involvement, communication, power and politics etc.) and social and cultural factors.[16]

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[13] A. Tylecot, Y. Cho and W. Zhang, "National Technological Styles Explained in Terms of Stakeholding Patterns, Enfranchisement", Technology Analysis & Strategic Management, 10(4) (1998), 423.

[14] S. Lee and G. Ungson, "Towards a Theory of Synchronous Technological Assimilation: The Case of Korea's Internet Economy", Journal of World Business, 43(3) (2008), 274.

[15] K. Aten and L. Nardon, "International Technology Management and National Culture", in H. Bidgoli (Ed.), The Handbook of Technology Management (2010), 757, 759 (citing L. Nardon and K. Aten, "Beyond a Better Mousetrap: A Cultural Analysis of the Adoption of Ethanol in Brazil", Journal of World Business, 43(3) (2008), 261).

[16] K. Munir, "Being Different: How Normative and Cognitive Aspects of Institutional Environments Influence Technology Transfer", Human Relations, 55(12) (2002), 1403.

Several researchers have compiled indices of societal culture that they have then used to predict the difficulties that might be expected in successfully transferring organizational practices or technologies across national borders. Interestingly, Jensen and Szulanski found that organizations engaged in transferring their organizational practices to an organization in another societal culture that attempted to adapt those practices to fit the societal culture of the receiving organization were less successful.[17] Another study of the influence of societal culture on the granting and receipt of technology transfer among national subsidiaries found that societal culture did not have a significant influence but that organizational culture was important to the success or failure of transfers.[18] In contrast to the results of these studies, however, are the findings of researchers who studied adoption of foreign technologies by Chinese industries and concluded that cultural affinity between the country where the technology originated and the country where adoption is being attempted (i.e., the degree of resemblance of the rules, customs and modes of communication in the two countries) was an important predictor of how well the foreign technology would be accepted.[19]

Adoption and use of information and communication technologies have arguably been the most popular topics for researchers interested in how societal culture influences issues related to technology management. In general, researchers have concluded that Aten and Nardon observed that "research has shown that national culture influences how technologists develop [information and communications technologies], the propensity of organizations and individuals to adopt specific technologies, and how individuals evaluate their use of information technology".[20] Studies in this area have typically relied on two of the dimensions of societal culture found in the Hofstede model: uncertainty avoidance and power distance.[21] Among the findings are that low uncertainty avoidance cultures perceive software projects as less risky[22] and technology evaluations are more favorable in low power distance or low uncertainty avoidance cultures[23]. However,

[17] R. Jensen and G. Szulanski, "Stickiness and the Adaptation of Organizational Practices in Cross-Border Knowledge Transfers", Journal of International Business, 35(6) (2004), 508.

[18] A. Cui, D. Griffith, S. Cavusgil and M. Dabic, "The Influence of Market and Cultural Environmental Factors on Technology Transfer Between Foreign MNCs and Local Subsidiaries: A Croatian Illustration", Journal of World Business, 41(2) (2006), 100.

[19] L. Phillips, R. Calantone and M. Lee, "International Technology Adoption: Behavior Structure, Demand Uncertainty and Culture", Journal of Business & Industrial Marketing, 9(2) (1994), 16.

[20] K. Aten and L. Nardon, "International Technology Management and National Culture", in H. Bidgoli (Ed.), The Handbook of Technology Management (2010), 757, 760 (citing, for a fuller review, D. Leidner and T. Kayworth, "Review: A Review of Culture in Information Systems Research: Toward A Theory of Information Technology Culture Conflict", MIS Quarterly, 30(2) (2006), 357).

[21] See generally A. Erumban and S. de Jong, "Cross-Country Differences in ICT Adoption: A Consequence of Culture?", Journal of World Business, 41 (2006), 302. For further discussion of the dimensions in the Hofstede model, see the Part on "Cross-Cultural Studies" in "Globalization: A Library of Resources for Sustainable Entrepreneurs" prepared and distributed by the Sustainable Entrepreneurship Project (www.seproject.org).

[22] M. Keil, B. Tan, K. Wei, T. Saarinen, V. Tuunainen and A. Wassenaar, "A Cross-Cultural Study of Escalation of Commitment Behavior in Software Projects", MIS Quarterly, 24(2) (2000), 299.

[23] D. Leidner, S. Carlsson, J. Elam and M. Corrales, "Mexican and Swedish Managers' Perceptions of the Impact of EIS on Organizational Intelligence, Decision Making and Structure", Decision Sciences, 30(3) (1999), 633.

conflicting results were found with respect to the relationship of power distance to technology adoption and diffusion with one set of researchers finding that adoption is more likely in low power distance countries[24] while another group of researchers concluded that high power distance is better suited for effective technology adoption and diffusion[25]. A similar conflict occurs when the influence of uncertainty avoidance on adoption is tested: Leidner and Kayworth found that adoption and diffusion of new technologies is less likely in higher uncertainty avoidance cultures[26] while Galliers et al. came to the opposition conclusion that low uncertainty avoidance was positively correlated to low adoption and diffusion of new technologies[27]. The individualistic/collectivist dimension in the Hofstede model was also used by Tan et al., who determined that people from individualistic societies were more likely to report bad news associated with information technology projects.[28] Finally, researchers relying on the dimensions of societal culture suggested by Hall[29] have argued that polychromic cultures are less likely to be troubled by technology delays and that information overload due to technology is more likely to occur in high context cultures.[30]

While Aten and Nardon acknowledged that the evidence is strong that societal culture influences the management of technological change they also argued that important research questions remain unresolved.[31] For example, they pointed out that technology and innovation management scholars have conceived of technological change as occurring in a non-linear process and this means that societal culture likely influences technology in varying degrees and at different points in time.[32] If this is true, more

[24] H. Hasan and G. Ditsa, "The Impact of Culture on the Adoption of IT: An Interpretive Study", Journal of Global Information Management, 7(1) (1999), 5.
[25] G. DeVreed, N. Jones and R. Mgaya, "Exploring the Application and Acceptance of Group Support Systems in Africa", Journal of Management Information Systems, 15(3) (1998), 197.
[26] D. Leidner and T. Kayworth, "Review: A Review of Culture in Information Systems Research: Toward A Theory of Information Technology Culture Conflict", MIS Quarterly, 30(2) (2006), 357.
[27] R. Galliers, "Information Systems and Culture: Applying "Stages of Growth" Concepts to Development Administration", Information Technology for Development, 8(2) (1998), 89.
[28] B. Tan, J. Smil, M. Keil and R. Montealegre, "Reporting Bad News About Software Projects: Impact of Organizational Climate and Information Asymmetry in an Individualistic and Collectivist Culture", IEEE: Transactions on Engineering Management, 50(1) (2003), 64.
[29] E. Hall and M. Hall, Understanding Culture Differences: Germans, French and Americans (1990). For summary description of the dimensions suggested by Hall, see the Part on "Cross-Cultural Studies" in "Globalization: A Library of Resources for Sustainable Entrepreneurs" prepared and distributed by the Sustainable Entrepreneurship Project (www.seproject.org).
[30] K. Aten and L. Nardon, "International Technology Management and National Culture", in H. Bidgoli (Ed.), The Handbook of Technology Management (2010), 757, 760-761 (citing K. Calhoun, J. Teng and M. Cheon, "Impact of National Culture on Information Technology Usage Behavior: An Exploratory Study of Decision Making in Korea and the USA", Behavior and Information Technology, 21(4) (2002), 293, and G. Rose, R. Evaristo and D. Straub, "Culture and Consumer Responses to Web Download Time: A Four-Continent Study of Mono- and Polchronism", IEEE: Transactions on Engineering Management, 50(1) (2003), 31).
[31] K. Aten and L. Nardon, "International Technology Management and National Culture", in H. Bidgoli (Ed.), The Handbook of Technology Management (2010), 757, 760-766.
[32] According to Garud and Rappa: "While cursory observations . . . suggest a linear progression from the conceptions of an idea to its commercial application, a more probing examination exposes a complex web of interactions between those who develop the technology, the physical artifacts they create, and the

research should be done on the factors that determine how and when culture influences the technological change process. For example, studies that have already been conducted have provided support for the possibility that certain sophisticated technologies develop and change relatively free of cultural influences and cultural differences have a larger impact in technology transfers when the technology importer is from a developing country.[33] Another interesting question is how national and organizational cultures, working simultaneously and in tandem, influence technology adoption and under what circumstances does the culture at one level take precedence over the culture at another level. Finally, research relating to technology transfer might be expanded to include more emphasis on how the use of technology by an importing organization influence the development and subsequent transfer of the technology throughout the broader society in which the importing organization is operating. Still another thing that needs to be considered is that societal culture is often measured at a single point in time, a practice which eases the research hurdles but ignores factors that have been recognized by scholars adopting a socio-cognitive approach to societal culture: culture is dynamic, multi-layered and non-deterministic. It is also recommended that due attention be given to the interactive influences of technology on culture and vice versa: in other words, how technological change influences societal culture.[34]

§1:2 Silicon Valley

According to Harris et al., technology management in Silicon Valley emphasizes ways to move quickly, retain flexibility and motivate IT workers and key strategies include treating IT decision as urgent business decisions, dispensing with unwieldy steering committees and reviews and conducting quarterly, rather than annual, reviews of projects and budgets to remain nimble; encouraging wide participation in testing and assessment of proposed new IT solutions ("crowdsourcing technology decisions") and community involvement in the design and building of new software and other processing technologies; and making sure that the best IT workers are provided opportunities to grow and assume leadership positions even it increases the risk that such person will eventually leave to pursue their careers at other companies.[35] A related article identified and discussed other technologies, management practices and cultural features believed to be contributors to the speed of IT development in Silicon Valley including the use of cloud and open technologies to enable rapid improvements, reliance on iterative

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institutional environments they foster." See R. Garud and M. Rappa, "A Sociocognitive Model of Technology Evolution: The Case of Cochlear Implants", Organization Science, 5(3) (1994), 344.

[33] See L. Phillips, R. Calantone and M. Lee, "International Technology Adoption: Behavior Structure, Demand Uncertainty and Culture", Journal of Business & Industrial Marketing, 9(2) (1994), 16 (sophisticated technologies); and B. Kedia and R. Bhagat, "Cultural Constraints on Transfer of Technology Across Nations: Implications for Research in International and Comparative Management", Academy of Management Review, 13(4) (1988), 559 (technology transfers into developing countries).

[34] K. Aten and L. Nardon, "International Technology Management and National Culture", in H. Bidgoli (Ed.), The Handbook of Technology Management (2010), 757, 765 (citing S. Barley, "Technology as an Occasion for Structuring: Evidence from Observations of CT Scanner and the Social Order of Radiology Departments", Administrative Science Quarterly, 31(1) (1986), 78 (discussing how introduction of CT technology influenced work group culture at two hospitals).

[35] J. Harris, A. Alter and M. Matos, "Silicon Valley Management Secrets: Make Your Tech Team Faster and More Innovative", Bloomberg Businessweek: The Management Blog (July 24, 2013).

development disciplines and tools to create systems quickly, and cultivation of an organizational culture that include impatience and openness.[36]

§1:3 Silicon Fen

Cambridge generally did not follow the lead of its counterparts in the US by imposing restrictions and economic conditions on the exploitation of intellectual property developed by researchers working with funds provided by Cambridge University. As a result, faculty members and others involved in University research activities had great latitude in using the resulting technology and associated intellectual property rights in spin off firms without the need to compensate the University through royalties or some form of equity ownership. In fact, it has been estimated that only a small percentage of the emerging companies in Silicon Fen could properly be characterized as direct spinoffs from the University. However, little effort was made to create a formal mechanism for exchange of information and technology between academia and industry and the region lacked the resource bank of experienced managers in the high technology area who could provide guidance and mentoring to those entrepreneurially oriented University staffers who were interested in exploring industrial opportunities. On the other hand, however, the University has played a valuable role in supporting the commercial development of technology as a logical consumer of the technologies and products created by emerging companies in the area and informal partnering between industry and academic has occurred through the frequent use of University graduate students by local companies as part-time labor.

One aspect of technology management is the scope and impact of contacts and relationships between Silicon Fen companies and local units of transnational corporations that have established R&D units in the area. Štrukelj and Dolinšek, who studied the internationalization of R&D in the Cambridge cluster, cited the report in The Cambridge Cluster Report 2004 that the University had "become a leading centre for industrial research laboratories with concomitant investments from major corporations such as AT&T, GlaxoSmithKline, Hitachi, Intel, Microsoft, Olivetti, Oracle, The Wellcome Trust, Toshiba, and others over the past twenty years" and also noted that information published by the Silicon Fen Business Report in 2007 confirmed that at least 19 transnational corporations had set up R&D units in the Cambridge cluster and that several of them had established formal collaboration programs with local research institutions.[37] For example, Hitachi's Cambridge Laboratory worked closely with the University's Microelectronics Research Centre and provided local researchers with access to work being done at other Hitachi research laboratories in Japan and in other parts of the world.[38] The Intel Research Cambridge Lab was located on the University campus near the University's Computer Laboratory and Department of Engineering, thus creating an easy path for intense collaboration between those University units and Intel researchers

[36] J. Harris, A. Alter and C. Kelly, "How to Run IT at the Speed of Silicon Valley", Wall Street Journal (June 27, 2013).
[37] P. Štrukelj and S. Dolinšek, "Internationalization of R&D in Two High-Tech Clusters and Cooperation of R&D Units in those Clusters", Journal of Industrial Engineering and Management, 3(2), 294, 300.
[38] Id.

under an open and cooperative research model that permits open distribution of the results of any collaborative research.[39] Intel also provided financing for University laboratories, internship opportunities for Cambridge students, access for those students to Intel laboratories and other resources to carry out their own research work and training and mentoring for University researchers. One of the byproducts of Intel's investment of capital, tangible assets and time was that University students and researchers gained a better understanding of Intel and thus were able to tailor their own research programs in ways that would ultimately provide benefits to Intel. Finally, Microsoft's Research Cambridge Laboratory, which was established in 1997, had become one of the largest computer science research laboratories in Europe and offered Microsoft researchers working there an opportunity to engage in "blue sky" pure research with collaborators from the University and elsewhere.[40] Like Intel, Microsoft had a long history of offering internships to University students and working closely with the University's Computer Laboratory, Statistics Laboratory and Department of Engineering.

§1:4 Japan

According to Whittaker and Cole, during the 1980s and early 1990s Japanese companies prospered using a technology management model that emphasized "low cost high quality precision hardware achieved through continuous process improvement in a framework of dense communication of design information across organization units".[41] Whittaker and Cole, following Odagari and Goto, referred to the Japanese innovation strategies of that period as a "productionist model" that relied heavily on substantial investments in large R&D efforts and making products efficiently so that they could incorporated swiftly and smoothly into manufacturing and marketing.[42] According to Odagari and Gato, the four key factors in the productionist model included a bias toward growth maximization (i.e., a willingness to invest in technology); familiarity of management with R&D, production and marketing; close links between the R&D, production and sales functions, and smooth transfer of new processes and products into production. Whittaker and Cole emphasized the importance of the fact that many Japanese directors had production and technological backgrounds which enhanced their ability to effectively manage technology and increased the likelihood that better evaluations would be made regarding the anticipated outcomes of R&D activities. Odagari and Goto also recognized the importance of Japan's educational system to private sector innovation in that universities were able to provide companies with well-educated individuals with generalized technical skills; however, Whittaker and Cole noted that Japanese universities had failed to provide the same levels of support for basic R&D that was provided by US universities and that under-funding of Japanese education R&D had severely limited the contribution of the country's universities to overall economic growth.

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[39] Id. at 301-302.
[40] Id. at 302-303.
[41] D. Whittaker and R. Cole, "Introduction", in D. Whittaker and R. Cole (Eds.), Recovering from Success: Innovation and Technology Managing in Japan (2006), 1, 13 (as cited in L. Lynn, "Recovering from Success: Innovation and Technology Managing in Japan (Review)", The Journal of Japanese Studies, 34(2) (Summer 2008), 543).
[42] H. Odagari and A. Goto, "The Japanese System of Innovation: Past, Present and Future", in R. Nelson (Ed.), National Innovation Systems (1993), 109.

However, as the 21st century began it became clear that companies from other countries around the world had caught up with the Japanese with respect to their ability to deliver production efficiency and product quality and that they were able to optimize their supply chains to achieve drastic reductions in costs and forge global strategic alliances that allowed them to accelerate the innovation necessary to address consumer demands in emerging markets. Commentators such as Yunogami suggested that Japanese companies were becoming increasingly burdened by an obsession with quality and reliability to the point where they were investing too much of their time and resources in providing more quality than prospective customers were willing to pay for and that this was impeding their ability to develop new products quickly and bring them to market in time to fend off the increasingly intense competition from firms in East Asia and elsewhere.[43]

In a 2010 paper on Japanese management culture and corporate innovation, White & Partners noted that while Japan continued to invest substantial amounts on R&D in both the corporate and public sectors and could boast of a higher education system that annually turned out large numbers of trained and skilled scientists and engineers, there remained significant barriers to corporate innovation that could only be overcome with somewhat radical changes to the country's management practices and culture.[44] Specifically, White & Partners argued that Japanese businesses needed to adopt a greater tolerance for risk taking that allowed for, and encouraged, mavericks and their crazy ideas and different approaches to business and made "failure" in the corporate setting acceptable; put in place reward systems that recognized outstanding individuals as well as group contributions to invention and innovation; and improve communication and openness within their workplaces. At a structural level, White & Partners called for changes in government policies to permit and promote industry restructuring through mergers, acquisitions, divestments and inbound foreign investment and implementation and support of programs that would allow greater job mobility within industries so that new ideas and experiences could flow more freely among companies. White & Partners suggested that efforts needed to be made at both the governmental and company levels to diversify the workforce and provide more opportunities for women and immigrants, a step that would certainly be difficult given the long-standing aversion to outsider in Japan and strong traditions regarding the respective roles of men and women in society.

While there have been concerns about the competitiveness of larger Japanese companies with respect to innovation on a global scale, small- and medium-sized firms in Japan have been recognized as technological leaders that have achieved and sustained dominant positions in specialized markets all over the world. A 2009 article in *The Economist* spoke of strong medium-sized technology companies in Japan as being "invisible yet indispensable" and provided a list of some of the reason that such companies have been so successful at innovation: handsome investments in R&D; strenuous efforts to protect "high-end" technology and knowledge so that it does not leave the company; ownership

[43] T. Yunogami, "Technology Management and Competitiveness in the Japanese Semiconductor Industry", in D. Whittaker and R. Cole (Eds.), Recovering from Success: Innovation and Technology Managing in Japan (2006), 70.
[44] A. White & Partners Ltd., Japanese Management Culture and Corporate Innovation (January 2010).

of their supply chains as well as investment in their own manufacturing equipment to control costs and remain independent from suppliers; maintenance of a deep understanding of their technology; attentiveness to the demands of customers for higher quality and reliability and a willingness to customize their products to meet customer demands that builds trust that becomes a significant barrier to entry; and accumulated knowledge about the relevant technologies and industries that is built up over a long period of time and institutionalized among managers and employees over long-term employment relationships with the company.

§1:5 France

In the early 2000s, a report prepared by the national Ministry for Research and New Technologies announced that the priorities of French national research should be based on establishing and maintaining a strong platform of high quality basic research and focusing on several specifically targeted initiatives in priority areas such as sustainable development, the energies of the future, the fight against cancer, the digital society and space.[45] The French government set a target of investing 3% of the country's GDP in R&D activities and mobilizing various institutions within the country to develop the human capital necessary to increase and maintain the desired pace of innovation. French officials also stressed the need to reduce reliance of public expenditures on research and create incentives R&D activities in the private sector, including not only in-house R&D projects but greater collaborations between companies and university laboratories in line with partnerships typically seen in the US and the UK and increased funding and support from not-for-profit associations and institutions. The report emphasized the need to improve the environment for investment in smaller companies engaged in the pursuit of innovative R&D and to improve the competitiveness of distribution of publicly funded R&D projects so that smaller companies received a larger share of those opportunities. Other priorities described in the report included implementation of tax incentive measures to encourage investment in innovation and establishment of "young innovative companies" and encouraging scientists in the public sector to become more involved in launching new companies focused on commercialization of technologies developed in their laboratories.

Martinsons and Davidson conducted a comparative study of the influence of societal culture on organizational implementation of BPR initiatives.[46] They found that the level of power distance ("PD") in the societal culture in which an organization operated had a significant influence on the involvement of employees in planning and decision making associated with BPR initiatives and that in France and other high PD cultures final authorization and initiation of BPR projects clearly came from the top of the organizational hierarchy, although recommendations for various changes may have

[45] French Ministry for Research and New Technologies, Research and Technological Development in France.

[46] M. Martinsons and R. Davison, "Globalization and Information Management Strategy: Cross-Cultural Perspectives", in H. Bidgoli (Ed.), The Handbook of Technology Management (2010) 653, 660-661.

originally been proposed by senior managers in the IT function.[47] In general, BPR was easier to authorize and initiate in the more centralized organizational structures typically found in high PD societies. PD also played a role in the degree to which employees were ready and willing to embrace some of the changes associated with BPR initiatives and the researchers observed that employees in high PD societies were not as interested in efforts to empower them or in taking on new responsibilities that also carried additional risks. It was also noted that employees in high PD countries were less interested in, and even anxious about, sweeping formal changes in organizational information systems given that they were used to operating in a centralized hierarchical structure that required much less in terms of formality and distribution/sharing of information. A final area in which PD played a significant role was in how employees accepted and adopted the new information systems ("IS") that are a typical part of BPR initiatives. Martinsons and Davidson found that organizations in higher PD societies, such as France, were less likely to tap into some of the purported benefits of the tools made available to them in their new IS. For example, they observed: "Firms operating in high PD cultures were less likely to develop and make use of formal IS plans or process models. Information systems in these contexts were used primarily for vertical communications to reinforce the hierarchical control of business activities." Martinsons and Davidson also noted that IS was seen by firms in high PD societies more as a tool to "monitor" operations in a growing business rather than to share information, a finding they believed to be consistent with what they referred to as an "autocratic information management strategy".

Martinsons and Davidson also noted that organizations in societies where the level of uncertainty avoidance ("UA") was high, such as France, often turned to IT as a means for reducing uncertainty through the implementation of forecasting and planning processes and that the level of UA also influenced the amount of planning involved in BPR initiatives.[48] They reported that managers in France, as well as other high UA countries such as Brazil and Japan, implemented extensive and detailed planning processes for their BPR projects in an apparent attempt to reduce project risks, and offered the following summary conclusions regarding the influence of UA on information management: "Our findings suggest that a systematic approach to information management will be accepted more easily in cultures where uncertainty avoidance and scientific management are high valued. Organizations that operate in cultures that are more comfortable with uncertainty would be less likely to invest in a detailed information management 'strategy'. They would also be less inclined to implement IS that specifically aim to reduce the level of uncertainty that would be faced by decision makers."[49]

Martinsons and Davidson suggested that many elements of BPR, including rhetoric based on military metaphors such as "blow up the old" and "shoot the stragglers", were

[47] The countries in their study were categorized as follows with respect to PD: Brazil (High); China (High); France (High); Japan (Moderate); Sweden (Low); and the US (Low). M. Martinsons and R. Davison, "Globalization and Information Management Strategy: Cross-Cultural Perspectives", in H. Bidgoli (Ed.), The Handbook of Technology Management (2010) 653, 655.

[48] M. Martinsons and R. Davison, "Globalization and Information Management Strategy: Cross-Cultural Perspectives", in H. Bidgoli (Ed.), The Handbook of Technology Management (2010) 653, 661-662.

[49] Id.

consistent with a highly masculine ("MAS") societal culture and that implementation of BPR often conflicted with ideas that were highly valued in countries that scored low on the masculinity measure such as cooperation and secure employment.[50] Not surprisingly, while the researchers observed some form of resistance to BPR in all of the countries that they studied the levels of resistance in high-MAS countries such as China, Japan and the US was characterized as "manageable" while resistance was greatest and most problematic in the low-MAS countries (i.e., France and Sweden). The level of masculinity played a role in the strategies that firms used to overcome employee resistance to the changes implicit in BPR initiatives. In China, a high-MAS country, financial incentives (i.e., bonuses tied to objective measures of improvements in performance) were used; however, firms in low-MAS countries such as France and Sweden opted for altering the pace of implementation so that organizational changes were introduced more gradually.

Interestingly, the presence of high individualism in the societal culture, such as the cases of France and the US, often had a disruptive influence on implementation of BPR initiatives because it undermined the authority of managers in firms in those cultures to take the directive actions necessary to launch the changes thought to be necessary for BPR to be successfully implemented.[51] Managers in high individualism cultures complained that those under their supervision wanted to retain the right to manage information "in their own way" and that this made it difficult to introduce and establish information management systems intended to promote consistency and uniformity across the entire organization. Firms from high individualism cultures such as France and the US needed to use a mix of team incentives and individual performance-based rewards in order to form and maintain product BPR teams. Finally, differences related to individualism versus collectivism were observed with respect to how well certain types of IS tools were accepted. For example, group communications tools were welcomed and readily adopted by firms in high collectivist countries while persons from high individualist cultures preferred new applications based on personal computers.

§1:6 Germany

In a study conducted in the early 1990s, Bond et al. found that average R&D intensity in German firms was larger than the corresponding figure for comparable UK companies and argued that the lower levels of R&D investment in the UK could likely be attributed to a corporate governance and finance framework in the UK that imposed higher requirements for the required rate of return on R&D and thus made it more difficult to obtain approval for R&D projects.[52]

Wildemann conducted a review of the published research on innovation management among small- and medium-sized German enterprises and observed that companies were frequently challenged by restricted technical opportunities, limited financial resources

[50] Id. at 662.
[51] Id. at 662-663.
[52] S. Bond, D. Harhoff and J. Van Reenen, Corporate R&D and Productivity in Germany and the United Kingdom (September 2002).

and shortcomings in the capacity of their personnel and that many firms had failed to invest in the creation and support of formal structures for innovation management such as forming individual departments focusing on research and development activities.[53] Wildemann also noted that the methods and tools used by German SMEs for innovation management were often deficient with decision makers typically lacking sufficient information about new ideas to determine which ones were the most promising candidates for further assessment and investment and operating without standardized management practices that led to lengthy and cost repetition of effort each time a new idea surfaced. Another issue that had a negative impact on the development of innovation culture among German SMEs was their lack of knowledge of the strengths of their own employees, which typically inhibited assignment of roles and responsibilities in R&D activities and implementation of training programs to address skill gaps. Finally, the ability of German SMEs to select the most appropriate innovation projects, and properly define the scope of projects that were selected, was hindered by a lack of information regarding market conditions and the technology requirements in those markets. In his own study of innovation management among 480 German companies, Wildemann found that respondents generally failed to pay sufficient attention to their customers and to competitors in making product development decisions and that poor internal communications with respect to R&D often led to duplicative activities and wasted resources.[54] Another issue that Wildemann uncovered was a widespread failure among respondents to protect their proprietary knowledge.

§1:7 Developing countries

The following sections include summaries of technology management activities, innovation systems and protection of intellectual property rights in various developing countries. As is the case with studies of product development in developing countries, research regarding technology management in those countries is relatively scarce in relation to the tremendous interest in the topic among researchers and consultants in the US and other developed countries; however, it is apparent that policymakers in the selected developing countries are keenly aware of the importance of science and technology for socio-economic development and global competitiveness of the firms. While developing countries have been active in new technologies performance has been relatively poor and serious questions remain as to which technologies should be adopted by developing countries and how their development and use should be managed. Technology management in developing countries is arguably distinguishable from the situation in industrial countries given that developing countries have large and pressing needs in basic areas and sectors including telecommunications, sanitation and healthcare which can and should be addressed through thoughtful use of technology. As is the case with advanced economies technology management in developing countries requires communication and cooperation among public and private organizations.[55]

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[53] H. Wildemann, R&D-Portfolio Management of German Industrial Enterprises—An Empirical Survey, International Journal of Technology Intelligence and Planning, 5(2) (2009), 191.

[54] Id. (citing H. Wildemann, "Am Kunden Vorbei", Harvard Business Manager, 30(3) (2008), 8).

[55] For further discussion see H. Sun, Management of Technological Innovation in Developing and Developed Countries (2012).

§1:8 --Brazil

The Ministry of Science and Technology, which was created in March 1985, is the central agency for science and technology in Brazil with supervisorial authority over several key agencies including Conselho Nacional de Desenvolvimento Científico e Tecnológico (National Council for Scientific and Technological Development), which is referred to as the "CNPq" and dedicated to the promotion of scientific and technological research and to the formation of human resources for research in the country; Financiadora de Estudos e Projetos (FINEP), which is devoted to funding science and technology in the country; Instituto Nacional de Pesquisas Espaciais (National Institute of Space Research); Instituto Nacional de Pesquisas da Amazônia (National Institute of Amazon Region Research); Instituto Nacional de Tecnologia (National Institute of Technology); and Secretaria de Política de Informática e Automação (Secretariat for Computer and Automation Policy).[56] Allocation of the resources available through the CNPq has often been subject to patronage politics and there has been intense competition for control of science, technology and higher education in Brazil among various groups including political parties, unionized university professors and employees, scientific societies and special interest groups within the scientific and technological community lobbying for more public resources and protection of national technology from international competition.

In Brazil, industrial property rights are governed by the Industrial Property Law, which contains guidelines barring acts of unlawful competition, as well as other specific provisions regarding the acquisition, effects and extinction of trademark, patent and industrial design rights, and also establishes criminal penalties for several types of industrial property rights violations.[57] The Brazilian Patent and Trademark Office is responsible for establishing and administering registration procedures as a condition to acquisition of industrial property rights in Brazil and Brazilian law provides protection for patents, industrial designs, copyrights (including software) and trademarks.

Balbinot et al. evaluated Brazil's technology management by looking at management competences of the Brazilian Technological Innovation Centers that were instituted as a result of the passage of the country's Law of Innovation in 2004.[58] The Law of Innovation was intended to encourage innovation and technological research within productive environments through the institutionalization of the Centers and stipulated that each Center should have at least six minimum competences: (1) ensuring the maintenance of institutional policy for stimulating the protection of invention, licensing, innovation, and other forms of technology transfer; (2) evaluating and classifying the results that come from research activities and projects as a consequence of the Law; (3) evaluating the request for independent inventors for the adoption of invention; (4) assessing the

[56] The discussion in this paragraph is adapted from Brazil, Country Studies, Library of Congress (2013), http://lcweb2.loc.gov/frd/cs/brtoc.html.
[57] Industrial Property Law, Law n. 9,279 of May 14, 1996.
[58] Z. Balbinot, J. Dias and R. Borim-de-Souza, "Unique Organizational Competencies of Brazilian Technology Innovation Centers", Journal of Technology Management and Innovation, 7(1) (March 2012).

desirability of and promote the protection of inventions developed at the Center; (5) assessing the desirability of publicizing the inventions developed at the Center, subject to intellectual rights protection; and (6) monitoring the processing of requests for, and maintenance of titles of, intellectual property at the Center.[59]

Balbinot et al. noted that the Centers were primarily located at public scientific and technological institutes, overseen by highly qualified directors (i.e., post-PhDs, PhDs, and Masters), and that the most noteworthy activities of the Centers appeared to be technology transfer, intermediation in the relationship between a university and companies, research support, administrative activities that sustained technological cooperation in negotiation, registration of innovation processes and developed products and dissemination of an ideology of innovation that is aimed at the business market.[60] As to the unique organizational competencies of these Centers the researchers identified the following: intellectual property; national patenting; consulting services provided by individual professors or researchers; and identification of areas of research excellence at scientific and technological institutes through the number of patents registered, number of scientific publications, and expressed through research groups and lines of research. Among these competencies intellectual property was found to be the most dominant and the researchers noted that it was significant that the Centers had, in general, failed to achieve organizational competency with respect to management of technical cooperation between universities and companies even through one of the primary purposes for their establishment had been to promote and facilitate such cooperation.[61]

§1:9 --China

The evolution of technology management and innovation in China has followed the path of economic and socio-political reforms and changes that have occurred in that country over the last several decades as a slow and steady transition has been made from the Stalinist model of industrialization to a decentralized and market-based economy. Technological requirements have changed for China as it has gradually moved from an emphasis on heavy industry to light industry and production of more consumer goods; however, while some effort has been made to deploy technology to develop new products most of the emphasis to date has been on using technology to increase production efficiency.[62] Spending on research and development (R&D) as a percentage of gross domestic product (GDP) has risen from 0.6% (1995) to 1.49% (2008), and reached 2% by the end of 2010 and the number of applications for new patents has also increased substantially, with China passing Japan, the previous leader, in 2012.[63] In spite of the apparent progress Chinese R&D has remained heavily driven by foreign companies' investments and is dispersed very unevenly across the country, with high R&D intensity concentrated in Beijing, Shanghai, Shaanxi and Sichuan.[64]

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[59] Id.
[60] Id. at 3, 8.
[61] Id. at 8-9, 12.
[62] J. Bartholdi, III, "Operations Research in China", Interfaces, 16(2) (Mar-Apr. 1986), 29.
[63] Bertelsmann Stiftung, BTI 2012—China Country Report (2012).
[64] Id.

China's admission to the World Trade Organization ("WTO") provided motivation for the country to initiate serious and extensive reforms to its system of intellectual property laws and regulations in order for it to become compliant with the minimum requirements in the WTO's Trade-Related Aspects of Intellectual Property Rights Agreement and, as result, China now has not only transformed its patent, trademark and copyright laws but has also implement regulations pertaining to standards measures, antitrust enforcement, service invention regulations and regulations related to criminal enforcement of intellectual property laws.[65] While progress has been slower with respect to recognition and protection of trade secrets there have been changes in applicable civil procedure laws. While the original movement relating to Chinese intellectual property laws was undoubtedly driven by a desire to gain access to the trade benefits associated with WTO membership government and business leaders have gradually come to recognize that intellectual property protection may actually be in the country's own self-interest as it moved from being a technology adaptor to an inventor/innovator. Not surprisingly, non-Chinese companies, particularly those in the US, have continued to complain that enforcement of the new and/or updated intellectual property laws remains poor and a US government official speaking in early 2013 commented: "We know that IP enforcement remains a serious problem for U.S. companies, as trademark counterfeiting and copyright piracy continues. As the number of Internet users in China continues to increase, infringers are increasingly using the Internet to sell counterfeit and pirated materials, including counterfeit pharmaceuticals. Companies continue to complain about bad faith trademark filing, the practice of intentionally filing for another party's trademark to take advantage of the first-to-file trademark system in China."[66]

The projected movement by the Chinese from technology adaptor to inventor/innovator is considered by many to be a key step for the long-term health and growth of the Chinese economy. An article published in November 2013 noted that Chinese manufacturers could no longer count on being able to compete globally based primarily on cheap labor and that, in general, Chinese companies "lag behind in critical technology" and must make a concerted effort to improve with respect to the skills, quality, maintenance and management necessary to create long-lasting, world-tested products designed and made in China and suitable for markets around the world.[67] The same article cautioned that "innovation doesn't come easy" for the Chinese, who have grown comfortable with strategies that "build upon existing technology, not generat[ing] revolutionary ideas", and argued that innovation at the levels necessary for the Chinese to compete with the US will not occur unless and until there is intensive reform of China's financial system to promote more effective support of private enterprise, further improvements in the protection of intellectual property and an overhaul of the educational system to generate a better balance between strong skills, the current emphasis and creative thinking, which is

[65] An extensive catalog of laws, regulations and related documents pertaining to China's intellectual property law system is available at World Intellectual Property Organization, Outline of the Regulatory Framework Outline of the Legal and Regulatory Framework for Intellectual Property in the People's Republic of China (PRC), http://www.wipo.int/wipolex/en/outline/cn.html.

[66] T. Rea, Intellectual Property Trends and Developments with China (January 28, 2013), http://www.uspto.gov/news/speeches/2013/rea_fordham_china.jsp.

[67] M. Schuman, "Why China Can't Create Anything", TIME (November 18, 2013), 38, 39.

generally ignored or not encouraged.[68] The government has taken steps to encourage innovation by developing a Medium and Long Range Science and Technology Plan, a National Patent Strategy and a National Talent Strategy and there has been a significant increase in patent applications by, and invention patents issued to, Chinese inventors. As part of its National Patent Strategy, China is looking to rapidly increase its number of domestic patent filings on a per capita basis and the number of overseas patent applications filed by Chinese inventors.

When surveying managers of US firms that have launched R&D activities in China Schuman found that they were confronted with culturally-based hurdles to innovation, particularly a reluctance among Chinese engineers to engage in independent research due, at least in part, to a "fear of failure" and discomfort with technological tinkering that did not have a clear path to tangible business results. One R&D manager attempted to overcome these barriers by providing funding for personal initiatives and launching workshops that used role-playing and other techniques to promote creative thinking among Chinese engineers. The initial results were encouraging as participants began to generate more patents and become more comfortable with the "critical questioning . . . [that is] . . . fundamental to R&D".[69] However, in spite of these initiatives the Chinese still have a lot of ground to make up, not only with the US but with other rivals in Asia such as Korea which has a substantial head start in making the transition to technologically sophisticated products manufactured at extremely high quality levels.[70] Another 2013 survey indicated that China's cultural predisposition toward collectivism likely explained why Chinese survey respondents felt that invention and innovation was a collective, rather than individual, effort and this result was perhaps predictive of team building as a means for encouraging R&D in China.[71] The same survey uncovered a global sentiment that China would overcome the aforementioned challenges to innovation and emerge, along with the US and Japan, as one of the leading inventive countries of the 21st Century and also found that an overwhelming percentage of Chinese believed that inventiveness is a quality that can be learned and nurtured.[72]

Zedtwitz conducted an extensive study of Chinese R&D internationalization among a group of technology-intensive Chinese firms using data collected from personal research interviews with senior R&D managers in selected companies and database research to determine what motivated companies from China to conduct R&D outside of China, what strategies Chinese firms employed in order to expand R&D internationally and what barriers and challenges did Chinese companies face in doing so that may have been more specific to them as being from a developing county.[73] As background, Zedtwitz

[68] Id. at, 40.
[69] Id. at 40-41.
[70] Id. at 40.
[71] J. Kluger, "TIME Invention Poll: The Spark of Invention", TIME (November 25, 2013), 84, 86.
[72] Id. at 86, 89.
[73] M. Zedtwitz, International R&D Strategies in Companies from Developing Countries–The Case of China (January 2005), 5-6. Zedtwitz explained that the Chinese firms in the studied sample operated 77 R&D units, 40 in China and 37 abroad, and that most of the units were quite small in size. Of the 37 R&D units located abroad 26 operated in advanced countries—predominantly in the US (11) and Europe (11)—and mostly served as listening posts or in product design roles. Interestingly, Zedtwitz opined that even at these

commented that it was important to understand that Chinese R&D activities were selected and conducted in a unique and specific environment that differs significantly from the situation driving MNCs from developed countries. For example, the Chinese companies that Zedtwitz studied were relatively young, and thus comparatively small, and remained focused on domestic markets and heavily reliant on local supply networks. Zedtwitz argued that much of the R&D carried out by Chinese companies was directed towards technological learning rather than discovery and development of truly innovative products and that this was consistent with their overall strategic approach of avoiding reliance on technological progress to dominate markets and industries and concentrating instead on exploiting scale economies using standardized products in markets with low barriers to entry.[74]

With regard to the motives and objectives of Chinese companies that elected to set up R&D abroad Zedtwitz noted at the outset that most market-oriented R&D was likely to be carried out domestically given that the companies must still focus on servicing their own huge and still growing home market and reported that Chinese firms internationalize R&D in advanced countries primarily to augment the technology sourcing from those countries that is already occurring through foreign inbound investment by advanced country MNCs in China.[75] He gave an example the decision of a Chinese automobile manufacturer to establish "listening posts" in the US, Germany, the UK, and France for the purpose of being close to major competitors (not markets) and their technological bases. Interestingly, Zedwitz argued that "[e]fficiency-driven rationales such as the exploitation of multiple time zones, critical mass of R&D, and local cost advantages, hardly play a role for Chinese companies abroad".[76] In contrast to the input-related rationales for R&D activities in advanced countries by Chinese companies when those companies established R&D initiatives in developing countries they generally did so as part of an overall initiative to exploit their technologies in developing markets through local product adaptation in order to support local business development.

Zedtwitz analyzed the strategies of the companies in his survey with respect to internationalization of R&D and innovation using an evolutionary model of international R&D that he had previously developed with a colleague.[77] He found that those Chinese companies in his survey group that had not established international R&D units used either an ethnocentric centralized R&D strategy (with a dominant R&D center serving far-away markets) or a geocentric centralized R&D strategy (where the R&D center

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modest levels China's R&D globalization has already reached a level comparable to some smaller but more advanced European countries. Id.

[74] Id. at 6 (citing E. Steinfeld, Chinese Enterprise Development and the Challenge of Global Integration (2002) (Chinese "firms focus on activities with low barriers to entry. Once the cost pressures become too intense, rather than moving upward into higher end activities or taking the time to develop proprietary skills, the firms diversify into other low entry barrier markets. The products themselves … are standardized.")).

[75] Id. at 8.

[76] Id. (citing O. Gassmann and M. von Zedtwitz, New Concepts and Trends in International R&D Organization, 28 Research Policy 231 (1999) for further explanation of "efficiency-driven rationales").

[77] Id. at 8-9 (citing O. Gassmann and M. von Zedtwitz, New Concepts and Trends in International R&D Organization, 28 Research Policy 231 (1999) for further explanation of their evolutionary model of R&D).

engages in cooperative projects with customers and other research institutes). He noted, however, that several of the companies in his survey group taken steps toward globalizing their R&D activities by first setting up one or two R&D sites abroad and then expanding toward the creation of true global R&D networks with R&D labs and joint ventures in a number of foreign countries. When building their global R&D networks Chinese companies tend to place their bets in countries where cutting-edge work is being done on emerging technologies and in countries such as India which offers lower labor costs, expertise in particular fields such as software design and a potential gateway to large local markets.

Finally, with respect to barriers and problems that Chinese companies needed to overcome in order to effectively expand their international R&D activities Zedtwitz found that the sampled companies frequently complained about a lack of cash and resources, particularly since profit margins in their home market were low and thus failed to generate significant cash that could be reinvested in R&D; lack of management expertise and experience relating to international R&D assignments and entry barriers in new markets.[78] Zedtwitz suggested that the feedback from the sampled companies could be added to the three principal challenges to internationalization for Chinese companies that came out of the earlier work of Steinfeld: (1) Chinese companies had a size disadvantage that made it difficult for them to compete head-to-head with much larger MNCs; (2) Chinese companies continued to emphasize local business integration despite increasing international sales (e.g., continuing reliance on local or regional supply chains rather than integrating with global technology suppliers); and (3) Chinese companies lacked sufficient product innovation required to charge higher profit margins, rather than just cost reduction through efficiency innovation.[79]

Zhang examined international R&D investment by Chinese companies in Europe and the US using in-depth multi-case studies.[80] In addition to identifying the technology exploitation and ambidextrous strategies, Zhang studied the organizational structure by the Chinese companies that he surveyed to coordinate and integrate domestic and foreign R&D activities and found that, in general, most of the companies retained a participative centralized structure while simultaneously seeking seeking a balance between internal connectivity and external autonomy. Zhang noted that overseas R&D units were generally given a fair amount of autonomy with respect to local human resource recruiting and vetting and selecting local partners and, partly because of their acknowledged proximity to the technology and the market they were given a good deal of latitude and influence in selecting new projects. However, in spite of the apparent autonomy given to the local R&D units abroad Zhang concluded that most of the final decision-making power remained in the hands of the headquarters office in China. Several reasons for centralization of authority were advanced by Zhang including the relatively small size of the foreign R&D units and the tendency of Chinese companies to

[78] Id. at 10.
[79] Id. at 9-10 (citing E. Steinfeld, Chinese Enterprise Development and the Challenge of Global Integration (2002)).
[80] J. Zhang, International R&D Strategies of Chinese Companies in Developed Countries: Evidence from Europe and the U.S., http://www.phdmanagement.sssup.it/documenti/awarded/zhang_thesis.pdf

retain most of their R&D employees and assets in their domestic headquarters offices.[81] Based on the evidence he collected in his survey Zhang believed that the most common managerial methods used by Chinese companies to coordinate overseas R&D units included formal coordination mechanisms; informal coordination and communication mechanisms, including IT-related communication tools; human resource transfer and project-based teamwork.[82]

Zhang was also interested in the apparently different learning modes that Chinese companies adapted when working in Europe as opposed to the US. With respect to investments in Europe Zhang found that the companies he surveyed tended to insulate themselves from local partners and engage in less explorative and more exploitative R&D activities including adaptation of technologies self-developed for the European market using good indigenous labor rather than local partnerships. Zhang described the approach taken in Europe as consistent with the "vocational-technical school model" which begins with training of Chinese R&D employees by local more advanced counterparts but then erodes as the skills of the Chinese become more advanced and the European mentors are substituted out for Chinese indigenous labor forces, ultimately leading to the insulation from explorative activities referred to above. In contrast, when the companies were investing in the US they tended to seek long-term local embeddedness by following the "Ph.D. student model" that included bonding activities such as employing local employees and cooperating with local partners. As a result, Chinese companies avoided isolation from the local innovation systems and sometimes became so successful at understanding and applying technologies learned during the explorations in the US that they were able to exploit those technologies directly into US markets before attempting to apply them back home in their own domestic market.[83]

§1:10 --India

Over the last several decades much of India's economic growth has been driven by the services sector, particularly information technology; however, there has also been a long-standing recognition of the need for diversifying the country's technological base that has led to initiatives such as support for a large network of technological institutes such as the Indian Institute of Technology and increased funding from national and state governments as well as internal donor agencies for specialized skills-based training.[84] Technology management has also become increasingly important for private companies in India forced to cope with international competition and has led them to take steps to shed their traditional aversion to risk and research to take on a broader range of commercial R&D and product development projects, particularly since much of the public investment in R&D in India remains narrowly confined to defense and space

[81] Id. at 117. Zhang explained that since China, like many emerging and developing countries had a large pool of inexpensive labor forces, R&D units set up abroad didn't have to grow to a complete and large scale R&D center and this allowed Chinese companies to keep a small number of elites at the foreign R&D units as an upstream link in their R&D chain, while the downstream links remain in the home country.
[82] Id. at 118.
[83] Id.
[84] Bertelsmann Stiftung, BTI 2012—India Country Report (2012).

applications.[85] Gar and Sumit noted that, in particular, Indian companies have placed greater emphasis on several key elements of technology management practice such as change management in their organizational cultures, use of technology and staff and strategic planning.[86]

The Indian Government, ambitiously seeking to launch a "decade of innovation" and create and protect a "new knowledge economy", has announced plans to develop a National Intellectual Property Rights strategy.[87] The intellectual property laws and regulations in India cover every significant aspect of intellectual property protection recognized in international standards; however, while the regulatory regime is extensive there are substantial concerns regarding enforcement. For example, in a 2013 study conducted by the US Chamber of Commerce, India was ranked at the bottom of the list with respect to patent protection and treaty participation and second-to-last, behind China and ahead of only Russia, with respect to copyright protection. Developments in the Indian pharmaceutical sector have been particularly provocative with the initial decision of local regulators to begin issuing compulsory licenses for patented drugs developed outside of India to facilitate local manufacturing, a condition many argue is illegal under international trade law, and the subsequent decision to revoke patents recognized in a large number of other countries.[88] The International Intellectual Property Alliance, noting that India could be one of the world's leading legitimate markets for the creative industries, has continuously slammed Indian regulators for failing to aggressively address widespread physical, online and mobile piracy in the Indian film, music and software markets.[89] The United State Trade Representative maintained India's position on its Priority Watch List for 2013 citing India's limited progress in improving its weak intellectual rights legal infrastructure and enforcement system and serious questions regarding the future condition of the innovation climate in India.[90]

§1:11 --Indonesia

The record is clear regarding the remarkable export performance of Indonesia from the mid-1980s through the later part of the 1990s, a period during which the annual growth rate of exports was around 12% for all products and substantially higher for

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[85] N. Forbes, "Technology and the Indian Industry: What is Liberalisation Changing?", Technovation, 19 (1999), 403; R. Krishnan and G. Prabhu, "Creating Successful New Products: Challenges for Indian Industry", Economic & Political Weekly, 34(31) (July 31-August 6, 1999), M114.

[86] R. Gar and Jain Sumit, "Managing Change: A Case of Indian Engineering Industry", Global Journal of Flexible Systems Management, 8(1 and 2) (2007), 65.

[87] P. Kerpen, India's Intellectual Property Failures Demand Obama's Attention (August 17, 2013), http://townhall.com/columnists/philkerpen/2013/08/17/indias-intellectual-property-failures-demand-obamas-attention-n1666509; R. Hollyman, An IPR Strategy to Keep India's Innovative Economy Moving Forward (November 2, 2012), http://techpost.bsa.org/2012/11/02/an-ipr-strategy-to-keep-indias-innovative-economy-moving-forward/

[88] P. Kerpen, India's Intellectual Property Failures Demand Obama's Attention (August 17, 2013), http://townhall.com/columnists/philkerpen/2013/08/17/indias-intellectual-property-failures-demand-obamas-attention-n1666509

[89] International Intellectual Property Alliance, 2013 Special 301 Report on Copyright Protection and Enforcement: India (2013).

[90] Office of the United States Trade Representative, 2013 Special 301 Report (2013), 38.

manufactured exports; however, while Indonesia was successful in diversifying its export base during the late 1980s and early 1990s more than half of the total value of its manufacturing exports as of 1996 came from resource- and labor-intensive industries such as food, garments, footwear and toys.[91] Okamoto and Sjoholm, who studied manufactured exports by technological categories among East Asian countries, found that Indonesian exports as of the end of the 1990s were of less technological sophistication in comparison with other countries in the region explaining, for example, that while about 50% of Thailand's exports could be categorized as being technologically complex the corresponding figure for Indonesia was only about 23%.[92]

Several researchers, notably a study conducted by Evenson and Westphal, have highlighted the importance of external sources of technological capability for Indonesia.[93] For example, a number of leading Indonesian textile firms benefitted from licensing arrangements with Japanese companies to gain access to proprietary technology.[94] In addition, purchases of imported capital goods, often from Japanese trading companies, were important contributors to development of export-driven Indonesian industries.[95] These same Japanese trading companies, along with other foreign buyers, provided Indonesian firms with essential marketing know-how and information on foreign markets that had been targeted by those firms for export activities. Indonesian companies also relied heavily on foreign technical experts, many of whom came from Japan.[96] Finally, foreign-owned subsidiaries, especially those with parent companies in Japan and Korea, operating in Indonesia played an important role in providing technical assistance through inter-company linkages.

While access to foreign assistance can be, and often is, useful to emerging countries such as Indonesia in shoring up gaps in the domestic technology portfolio it does not guarantee the continued availability and improvement of the country's technological base and eventually countries must be prepared to invest in internal research and development ("R&D"). Writing in 2001 Okamoto and Sjoholm observed that R&D expenditures as a share of GDP were low in Indonesia; however, they did concede that many Indonesian companies were initiating some R&D activities with the most promising initiatives

[91] H. Hill and Thee Kian Wie, (Eds), Indonesia's Technological Challenge (1998); Y. Okamoto and F. Sjoholm, Technology Development in Indonesia (May 2001); S. Lall, Technology Policies in Indonesia, in H. Hill and Thee Kian Wie (Eds.), Indonesia's Technological Challenge 138 (1998).
[92] Y. Okamoto and F. Sjoholm, Technology Development in Indonesia (May 2001).
[93] See, e.g., R.E. Evenson and L.E. Westphal, "Technological Change and Technology Strategy", in J. Behrman and T.N. Srinivasan, (Eds.), Handbook of Development Economics Vol. III (1995), 2264; M.P. Pangestu, "The Indonesian Textile and Garment Industry: Structural Change and Competitive Challenges", in M. E. Pangestu and Y. Sato, (Eds.), Waves of Change in Indonesia's Manufacturing Industry (1997) (main sources of technological capabilities among Indonesian textile companies was foreign including imports of capital equipment and provision of support services); and A. Berry and B. Levy, Indonesia's Small and Medium-Size Exporters and their Support Systems (1994) (private, especially foreign, external channels were pivotal sources of technology for Indonesian small and medium-sized enterprises involved in exporting garments, rattan furniture, and carved wooden furniture).
[94] Y. Okamoto and F. Sjoholm, Technology Development in Indonesia (May 2001).
[95] R.E. Evenson and L.E. Westphal, "Technological Change and Technology Strategy", in J. Behrman and T.N. Srinivasan, (Eds.), Handbook of Development Economics Vol. III (1995), 2264.
[96] Y. Okamoto and F. Sjoholm, Technology Development in Indonesia (May 2001).

appearing in scale-intensive, differentiated and high-technology industries.[97] On balance through the researchers believed that R&D activities were not, at least at that time, a major and significant source of technological capability in Indonesia. Hill, writing in the mid-1990s, criticized Indonesia's public R&D institutes as ineffective and noted in particular that they lacked adequate funding, which prevented them from hiring qualified staff, and operated without strong ties with the private sector, a situation which often led to inefficient pursuit of research programs that were chosen by politicians and bureaucrats rather than responding to demands from firms and industries.[98]

Institutional and governmental shortcomings have also hampered technology development and management in Indonesia. For example, the ability of the workforce to create and absorb new technologies has been undermined by shortages of skilled professionals and in the late 1990s Hill and Thee noted that the lack of an adequate pool of skilled labor in Indonesia in comparison to other East Asian countries was attributable to the low proportion of Indonesians enrolled in, or graduating from, science and technology courses at tertiary level.[99] Thee and Lall have been critical of the failure of Indonesia to establish institutional solutions for metrology, standards, testing, quality assurance and productivity and to provide industry-wide technical training and assistance.[100] Finally, governmental efforts to target and promote indigenous technological capability in high-technology industries have failed due to shortcomings in management and regulatory experience and weaknesses in the underlying research, education and technical infrastructure.[101]

Indonesia has continuously updated its laws and regulations pertaining to intellectual property rights to conform to international standards and is a signatory to numerous major international agreements protecting intellectual property rights; however, surveys routinely place Indonesia near the bottom in rankings of Asian countries with respect to protection and enforcement of intellectual property rights and complaints are often heard regarding software, audio and video disk piracy, pharmaceutical patent infringement and apparel trademark counterfeiting.[102] In 2013 the International Intellectual Property Alliance complained that the piracy situation in Indonesia remained severe and that Indonesian enforcement authorities and courts have failed to sufficiently curtail copyright infringement activities and invest sufficient resources to conduct raids and vigorously

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[97] Id.

[98] H. Hill and Kian Wie Thee (Eds.), Indonesia's Technological Challenge (1998). See also S. Lall, "Technology Policies in Indonesia", in H. Hill and Kian Wie Thee (Eds.), Indonesia's Technological Challenge (1998); Kian Wie Thee, "Determinants of Indonesia's Industrial Technology Development", in H. Hill and Kian Wie Thee, (Eds.), Indonesia's Technological Challenge (1998).

[99] H. Hill and Kian Wie Thee (Eds.), Indonesia's Technological Challenge (1998), 94.

[100] Kian Wie Thee, "Determinants of Indonesia 's Industrial Technology Development", in H. Hill and Kian Wie Thee (Eds.), Indonesia's Technological Challenge (1998), 127; and S. Lall, "Technology Policies in Indonesia", in H. Hill and Kian Wie Thee (Eds.), Indonesia's Technological Challenge (1998).

[101] H. Hill, "Indonesia's Great Leap Forward?: Technology Development and Policy Issues", Bulletin of Indonesian Economic Studies, 31(2) (1995) 83, 118; and D. McKendrick, "Obstacles to 'Catch-up': The Case of the Indonesian Aircraft Industry", Bulletin of Indonesian Economic Studies, 28(1) (1992), 39, 64.

[102] Indonesia, Country Commercial Guides, US Commercial Service, http://export.gov/indonesia/doingbusinessinindonesia/index.asp.

prosecute offenders.[103] The United State Trade Representative maintained Indonesia's position on its Priority Watch List for 2013 citing gaps in Indonesia's intellectual property laws and regulations and the ineffectiveness of Indonesia's enforcement efforts with respect to challenges such as rampant piracy and counterfeiting, including growing Internet piracy, and widespread availability of counterfeit pharmaceutical products.[104]

§1:12 --Korea

The Korean Overseas Information Service ("KOIS") reported that Korea's prowess in science and technology ("S&T") grew steadily along with the country's rapid economic development since the 1980s and that the country's investments in technology (measured both as a percentage of GDP and overall governmental expenditures), as well as the number of specialists engaged in S&T, increased substantially from 1980 to 2000.[105] According to the KOIS, by 2000 Korea had risen to fifth in the world in the S&T achievement indicator developed by the United Nations Development Program, an assessment that was based on a variety of measures including patent registration, technology-based exports and overall education levels. Korea's technology-related prowess was translated into commercial success in the form of high-quality, value-added products in a number of high technology sectors including semiconductors, computers, wireless communication devices and automobiles. In fact, by the end of the 2000s these sectors accounted for almost 40% of Korea's total exports and Korean firms had achieved world-class status and held global rankings of first in shipbuilding, fourth in steel and tenth in automobiles.[106]

The KOIS cautioned, however, that the early 2000s was a time of growing concerns regarding S&T in Korea as the number of young students electing S&T-related careers started to decline, morale among scientists and engineers soured and questions were raised regarding the efficiency of the country's investment programs relating to technology.[107] In response, the government created the National Science and Technology Council, chaired by the President and including all of the cabinet members related to S&T, with stated goal of enhancing the efficiency of Korean R&D investment by concentrating on development of technologies in the fields of information technology, biotechnology, nanotechnology, environmental technology, cultural contents technology and space science. Related steps included increased governmental budget amounts for basic science, establishment of a National Research Fellowship System and new initiatives to internationalize Korean R&D activities by opening Korean R&D projects to foreign institutions and researchers. The government also announced plans for promoting

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[103] International Intellectual Property Alliance, 2013 Special 301 Report on Copyright Protection and Enforcement: Indonesia (2013).

[104] Office of the United States Trade Representative, 2013 Special 301 Report (2013), 38.

[105] South Korea Profile, http://www.nationsonline.org/oneworld/korea_south_profile.htm (based on information provided by the Korean Overseas Information Service).

[106] Pricewaterhouse Coopers, Doing Business in Korea 2009 (May 2009), 10.

[107] The discussion in this paragraph is based on information provided by the Korean Overseas Information Service and adapted from South Korea Profile, http://www.nationsonline.org/oneworld/korea_south_profile.htm.

the development of service sectors including education, information technology, design, consulting, media and medical care.[108]

With respect to intellectual property rights in Korea, Nomura et al. observed in 2013 that "[t]he environment for protecting and enforcing [intellectual property] right has been improved in Korea recently" and pointed out Korea's efforts to build a network of free trade agreements with US and the European Union have included commitments to "high levels of protection and enforcement of [intellectual property] rights" and to "mak[ing] changes in its domestic laws as necessary".[109] They cautioned, however, that "many counterfeit goods remain on the market and in retail stores in Korea . . . [and that] . . . the enforcement system against the infringement of patent, utility and design rights should further be improved and expanded".[110] In a similar vein, the Heritage Foundation reported in 2012 that the Korean government appears to have recognized the importance of, and increased its efforts with respect to, intellectual property rights protection but that "[p]rotection of intellectual property rights needs to be improved, as piracy of copyrighted material is significant."[111]

§1:13 --Mexico

In an extensive report on building human capital in Mexico released in 2005 Jackson noted that Mexico was trying to create a platform that would allow it to compete in the new global marketplace, a step that Jackson argued would require sufficient investment in science and technology to shift the Mexican economy away from its traditional reliance on agriculture and low-value-added manufacturing in areas such as textiles and steel toward participation in high-value-added sectors such as software, consumer electronics and pharmaceuticals.[112] Mexico, like other emerging market economies such as China and India, had a long history of relying on low-cost labor as its competitive advantage but realized that they would need to follow those countries in making a transition to high technology sectors by setting aside large amounts of capital for research and development ("R&D"). Unfortunately, Mexico's annual investment in science and technology development, including education, was well below 1% of GDP during the early 2000s, an effort that lagged far behind competitors such as the US, China and Korea, and the percentage of workers involved in R&D activities was also quite low.[113] Jackson observed that the ability of the government to achieve its lofty goals for science and technology would depend on finding the necessary public funds and commitment from the private sector, which was contributing just one-third of total R&D funding in Mexico—a low share by international standards.[114]

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[108] Pricewaterhouse Coopers, Doing Business in Korea 2009 (May 2009), 10.
[109] T. Nomura, S. Okada and T. Yoshizaki, Features of IP Rights Enforcement in Korea and China (April 2013), 3-4.
[110] Id. at 4.
[111] South Korea, Heritage Foundation Economic Freedom Score 2012, http://www.heritage.org/index/pdf/2012/countries/southkorea.pdf.
[112] R. Jackson, Building Human Capital in an Aging Mexico: A Report of the U.S.-Mexico Binational Council (2005), 21.
[113] Id. at 21-22.
[114] Id. at 22.

Another report issued in 2006, which was jointly prepared by Mexico's National Science and Technology Council and the Center for Strategic and International Studies, noted that Mexico lagged well behind other Organisation for Economic Co-operation and Development (OECD) countries on a number of traditional measures of innovation, including number of patents issued, number of higher degrees in science and engineering and, as mentioned above, private and public sector investment in R&D, and observed that Mexico needed to take steps to improve its skills with regard to innovation since its ability to compete based on lower wages was eroding quickly in the face of competition from a number of countries in Asia.[115] In order to cope with this situation, the report made the following recommendations[116]:

- Develop a national consensus among politicians, businesspeople and labor leaders to depoliticize programs and projects that are intended to promote innovation. This should include development and implementation of a national strategy that can be endorsed and continuously supported by all relevant stakeholders, and dedicated funding and creation of quasi-governmental agencies or departments to promote innovation.
- Pursue soft infrastructure improvements to create a better environment for the pursuit of innovative activities, including adequate business laws and regulations, protection for intellectual property, effective courts and enforcement structures and a flexible financial system.
- Build and expand regional innovation clusters anchored on a university or transportation hub and supported by localized incentives and focused financial support to create and maintain the necessary infrastructure. The report acknowledged that Mexico already had a number of cities and regions with an established research base and international connections—notably, the area in and around Guadalajara, which had developed an infrastructure supporting the electronics and information technology industry and is often referred to as the Silicon Valley of Mexico; however, the task was to build and exploit those advantages through the cluster model.
- Create incentives and remove regulatory barriers to connecting entrepreneurs and their companies with university research activities.[117] The report noted that

[115] J. Lewis, National Policies for Growth and Innovation in Mexico (June 2006). Another interesting summary of the national and regional innovation infrastructure in Mexico can be found in T. Barber, High-Tech Innovation in Emerging Markets: The Case of Mexico (Graduate Thesis Submitted to The Fletcher School, Tufts University, Spring 2005), http://repository01.lib.tufts.edu:8080/fedora/get/tufts:UA015.012.DO.00071/bdef:TuftsPDF/getPDF

[116] J. Lewis, National Policies for Growth and Innovation in Mexico (June 2006), vii-viii.

[117] Barber included the following description of the conclusions reached by Casas et al. with respect to university research in Mexico as of 2000: "Mexican higher education institutions carry out the majority of R and D activity in Mexico, but the country is still a laggard in terms of knowledge production at an international level. Its technology and engineering programs receive little government or private sector support, and the knowledge production (measured in terms of scientific publications produced) is below average for industrialized nations and for some Latin American countries." T. Barber, High-Tech Innovation in Emerging Markets: The Case of Mexico (2005), http://repository01.lib.tufts.edu:8080/fedora/get/tufts:UA015.012.DO.00071/bdef:TuftsPDF/getPDF (citing R. Casas, R. De Gortari and M. Luna, "University, Knowledge Production and Collaborative Patterns with Industry", in M. Cimoli (Ed.) Developing Innovation Systems: Mexico in a Global Context (2000)).

technology transfer mechanisms were needed to efficiently commercialize the products that could be developed based on the efforts of university researchers in Mexico.

- Increase the number of graduate researchers, the amount of funding for research and development and the share of the private sector contribution to overall research and development funding in Mexico. The report repeated the findings and warnings of other researchers regarding Mexico's underinvestment in research and development and higher education and called for more incentives for private sector investment in research and development, including improvement of the soft infrastructure that would provide private firms with more certainty that they will be able to appropriate the fruits of their efforts.
- Create new initiatives to promote more foreign direct investment, cross-border partnerships and technology transfers. The report noted that the menu of issues that have engaged the US and Mexico in bilateral initiatives—law enforcement, narcotics, border security and pollution—should be expanded to include identifying and supporting innovation-based projects that could improve the Mexican economy and provide benefits throughout North America.

The 2013 survey published by the Intellectual Property Rights Index ranked Mexico 49th out of 130 countries worldwide (and 5th out of 23 countries in Latin America) with respect to security of intellectual property rights and noted modest improvements in protection and enforcement of intellectual property rights, an area where Mexico's performance still placed it a little below the middle of the global pack.[118] In 2013 the International Intellectual Property Alliance conceded the importance of Mexico as a key export and foreign sales market for US businesses but cautioned that the market was becoming significantly limited for US copyright industries due to the chronic problem of high levels of piracy of copyrighted works in Mexico.[119] In 2013 the United States Trade Representative maintained Mexico's position on its Watch List and while praising Mexico's accession to the Madrid Protocol and adoption of guidelines for protection of pharmaceutical test data criticized Mexican authorities for inadequate enforcement of intellectual property rights that has contributed to the continuing widespread availability of pirated and counterfeit goods in Mexico.[120]

§1:14 --Russia

R&D has been declared a top priority of the Russian government and received the personal attention of Presidents Dmitry Medvedev and Vladimir Putin. However, government action has so far focused on an isolated, though expensive, pet project (the creation of a Russian Silicon Valley near Moscow), which is not having a broader impact

[118] Property Rights Alliance and Americans for Tax Reform Foundation, Intellectual Property Rights Index (2013 Report), http://www.internationalpropertyrightsindex.org/profile?location=mexico (overall rankings based on a combination of measures of protection of intellectual property rights, patent protection and copyright piracy and based on work performed by the Property Rights Alliance (www.propertyrightsalliance.org)).

[119] International Intellectual Property Alliance, 2013 Special 301 Report on Copyright Protection and Enforcement: Mexico (2013).

[120] Office of the United States Trade Representative, 2013 Special 301 Report (2013), 51.

on the innovation potential of the Russian economy. Spending on R&D has hovered around 1% of gross domestic product (GDP) in recent years. Former President Dmitry Medvedev announced plans in 2010 to create Russia's own version of Silicon Valley in Skolkovo, outside of Moscow, and won pledges from an impressive array of global technology companies including Intel, Microsoft, Siemens, Samsung and Cisco to invest in Russia's technology sector; however, once Vladimir Putin returned to the presidency in 2012 political intrigue and rivalries have caused the project to stall.[121]

Technology management in Russia, including strategies for internal development and external acquisition, remains strongly influenced by cultural and political factors. To the extent that internal development of new technologies depends on a willingness and ability to plan and create a collaborative environment Russian firms labor under a tendency to use short-term criteria in decision-making and business development due to the turbulence in their external environments.[122] Internal collaboration is often difficult because of the propensity of Russian entrepreneurs to zealously guard their plans and share little information with others in the organization, much less with outside partners that might be able and willing to provide support for research and development in the form of technical assistance and/or funding.[123]

Collaborations with outside companies, such as Western firms looking to invest in the Russian marketplace, have typically been limited to sales opportunities in promising markets (e.g., in food and tobacco industries, consumer goods production and services provision) rather than technology opportunities and parties from both sides have typically been quite reluctant to work together on R&D projects.[124] However, some foreign companies, particularly those involved in information and communications technology, have engaged in R&D cooperative arrangements and/or opened R&D centers in Russia in order to gain access to what they perceive to be a large amount of highly educated personnel with an attractive quality-cost ratio.[125] Those Russian companies that have been open to working with Western partners have gained access to state-of-the-art technology and business know-how relating to quality control and other management

[121] Kremlin Intrigue Threatens Russia's Silicon Valley, http://www.businessweek.com/articles/2013-07-18/kremlin-intrigue-threatens-russias-silicon-valley

[122] M. A. Hitt, D. Ahlstrom, M. T. Dacin, E. Levitas and L. Svobodina, "The Institutional Effects on Strategic Alliance Partner Selection in Transition Economies: China vs. Russia", Organization Science, 15(2) (2001), 173.

[123] G. D. Bruton and Y. Rubanik, "Resources of the Firm: Russian High-Technology Startups and Firm Growth", Journal of Business Venturing, 17(6) (2002), 553.

[124] S. Boltramovich, P. Filippov and H. Hernesniemi, Innovation System and Business Environment of Northwest Russia (2004); and D. A. Dyker, "Technology Exchange and the Foreign Business Sector in Russia", Research Policy, 30(5) (2001), 851 (also commenting that Russian scientific and industrial leaders tended to view foreign business with suspicion, whereas foreign businessmen viewed Russia as a difficult environment and a poor risk in investment terms).

[125] A. Dynkin and N. Ivanova, "Technological Innovation in Russia", Journal of Product Innovation Management, 15(5) (1998), 476; and S. Boltramovich, P. Filippov and H. Hernesniemi, Innovation System and Business Environment of Northwest Russia (2004).

issues, intangible assets that are especially valuable and scarce in Russia due to the lack of extensive exposure to international levels of technical and quality standards.[126]

Russia's accession to membership in the World Trade Organization in 2012 was preceded by a long and extensive process of reforms to the country's laws and regulations pertaining to intellectual property rights including initiatives taken in order to comply with commitments made in a 2006 bilateral agreement between the US and Russia on intellectual property rights. In 2012 Russia announced that it shared the beliefs of the US that "strong IPR protection and enforcement are vital to promoting innovation and creativity by securing the rights of innovators and the creative community, attracting high-technology investment, and fostering the job necessary for long-term sustainable growth"; however, in spite of the formal agreements and public statements significant issues remain regarding intellectual property protection in Russia and the United States Trade Representative continued to include Russia on its Priority Watch List for 2013 and noted, in particular, that concerns continued regarding "inadequate enforcement against the growing problem of online piracy".[127]

Valdaytsev and Sergeyev argued that Russians are fully aware of the need for radical innovation in technology among both business and government in Russia but problems with respect to improving Russia innovation systems have festered due, in large part, to a lack of financial support.[128] They noted that Russian companies can no longer escape treacherous and intense foreign competition as Russia continues its path toward full integration into the world economic and trade community by opening its markets and that Russian companies need to acquire or develop new technologies that can be used to create products that fend off foreign competitors with better products and technologies. However, projects focusing on radical innovation, or even just significantly reducing the technology gap between Russian companies and their foreign competitors, require a significant amount of money and long-term patience from investors, both of which are hard to find in Russia where persistently high inflation rates drive up the demands of investors with respect to their return on investment given the risks associated with the innovation projects. Investors are also rightly concerned about technological backwardness in Russia, administrative delays with respect to approval of investments, corruption and weak enforcement of intellectual property rights. Given the high cost of equity investment to companies and the reluctance of investors to give up control of their capital in equity-based deals Russian companies turned to debt financing to support their technical re-engineering projects; however, this strategy led to financial distress, even bankruptcy, a significant amount of times. Another factor influencing the development of Russia's innovation systems include the continued strengthen of national technical and environmental standards by the government, directives that arguably complicate the R&D

[126] A. Dynkin and N. Ivanova, "Technological Innovation in Russia", Journal of Product Innovation Management, 15(5) (1998), 476; G. Bruton and S. Samiee, "Anatomy of a Failed High Technology Strategic Alliance", Organizational Dynamics, 27(1) (1998), 51; and J. Hagedoorn and J. Sedaitis, "Partnerships in Transition Economies: International Strategic Technology Alliances in Russia", Research Policy, 27(2) (1998), 177.

[127] Office of the United States Trade Representative, 2013 Special 301 Report (2013), 41.

[128] The discussion in this paragraph is adapted from S. Valdaytsev and A. Sergeyev, Technological Innovations in Russia (2011).

issues already confronting Russian companies. Valdaytsev and Sergeyev recommended that that the Russian government pay more attention to providing direct support from the federal budget for major national-scale private innovation projects and that Russian companies should carefully manage their capital structure through benchmarking and developing capital structure optimization techniques which take into account both industry peculiarities and innovation strategy special features.

§1:15 --South Africa

South Africa has developed a number of leading technologies and been recognized worldwide for its technological and quality standards, particularly in the fields of energy and fuels, steel production, deep-level mining, telecommunications and information technology, and manufacturing activities in South Africa have become increasingly technology-intensive with high-technology manufacturing sectors such as machinery, scientific equipment and motor vehicles capturing a growing share of total manufacturing output in the country.[129] In addition, South African governmental departments, like those in many other African countries, have launched a series of initiatives to encourage and support the improvement and expansion of information, communication and knowledge technologies in South Africa as a means for achieving broad-based growth and equitable socio-economic development.[130] The 2013 survey published by the Intellectual Property Rights Index ranked South Africa 20th out of 130 countries worldwide (and first among 23 countries in Africa) with respect to security of intellectual property rights.[131]

§1:16 --Turkey

Analysts have reported that Turkey has been making good progress in the areas of science and research and development (R&D) including significant increases in funding for R&D, particularly industrial R&D, and announced plans for establishing new private-sector R&D centers and preparing a national science technology and innovation action plan.[132] Turkey considers technology development and management a key ingredient to its economic development. With this in mind, in 1991, it created the Technology Development Foundation of Turkey (TTGV), a nongovernmental organization that acts as an intermediary between public funds and the private sector in order to support the international competitiveness of Turkish industry through improved technology management. An example of how this emphasis on technology management applies to specific industries can be seen in the automotive industry. Since the 2001 crisis that

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[129] South Africa: Open for Business, http://www.southafrica.info/business/investing/open.htm#industrial#ixzz2LIvouRDi.

[130] M.O. Oberholzer, A View on ICT Policy Forming Initiatives in South Africa: The Social Constitution of ICT Policies in Developing Countries, in Challenges of Information Technology Management in the 21st Century: 2000 Information Resources Management International Conference (2000), 937.

[131] Property Rights Alliance and Americans for Tax Reform Foundation, Intellectual Property Rights Index (2013 Report), http://www.internationalpropertyrightsindex.org/profile?location=south%20africa (overall rankings based on a combination of measures of protection of intellectual property rights, patent protection and copyright piracy and based on work performed by the Property Rights Alliance (www.propertyrightsalliance.org)).

[132] Bertelsmann Stiftung, BTI 2012—Turkey Country Report (2012).

struck Turkey, the industry has focused on technology and quality management, R&D, global competition and highly-skilled human resources. Under the coordination of the Ministry of Industry and Trade, an Automotive Industry Strategy Paper was prepared based on contributions from the private sector, as well as, relevant public institutions and organizations. According to the Paper, the main objective for the sector is "increasing competitiveness and managing the transformation."[133] With this in mind, the specific objectives were ensuring technological deepening in the sector, increasing added value in production, and transforming Turkey into the most competitive production and R&D center in the region.

The 2013 survey published by the Intellectual Property Rights Index ranked Mexico 55th out of of 130 countries worldwide (and 9th out of 24 countries in Central and Eastern Europe) with respect to security of intellectual property rights and noted modest improvements in protection and enforcement of intellectual property rights, an area where Turkey's performance still placed it a little below the middle of the global pack.[134] In 2013 the United States Trade Representative maintained Turkey's position on its Watch List, cited ongoing concerns of US intellectual property rights holders regarding exports from, and transshipments through, Turkey of counterfeit and pirated products (particularly luxury goods) and admonished Turkey to invest in additional resources and training for customs officials and judges on enforcement of intellectual property rights.[135]

§1:17 --Vietnam

During the 1990s, as Vietnam began its efforts to transition to a market-based economy, the Vietnamese government issued a number of policies relating to science and technology ("S&T") activities aiming to improve the potential impact on socio-economic development. A National Council for Science and Technology Policies was formed to advise the head of state regarding management of science and technology and the state itself was charged with building and directing implementation of S&T development plans; deciding on S&T policies, investing in and encouraging sponsorship for science with priority given to spear-headed sciences and technologies; managing and efficiently using S&T research organizations and scientific information; and managing standards, measurements, product quality; industrial property and technology transfer.[136] However, progress has been slow and Bertelsmann Stiftung reported that while research and development expenditures in Vietnam increased from 0.2% of gross domestic product (GDP) in 2005 to 0.7% in 2009, they remained below the global average.[137] Private sector investment in R&D has lagged even farther behind and government officials have

[133] "Turkey Creates Roadmap in Industry with Strategy Paper", Today's Zaman (January 6, 2011).
[134] Property Rights Alliance and Americans for Tax Reform Foundation, Intellectual Property Rights Index (2013 Report), http://www.internationalpropertyrightsindex.org/profile?location=turkey (overall rankings based on a combination of measures of protection of intellectual property rights, patent protection and copyright piracy and based on work performed by the Property Rights Alliance (www.propertyrightsalliance.org)).
[135] Office of the United States Trade Representative, 2013 Special 301 Report (2013), 54-55.
[136] R&D System in Vietnam, vietnam.nsc.gov.tw/public/Attachment/63231815471.doc
[137] Bertelsmann Stiftung, BTI 2012—Vietnam Country Report (2012).

bemoaned the fact that their failure to investment in R&D has caused Vietnamese companies to miss out on new technologies and fall behind in the global marketplace.[138]

Nguyen et al. surveyed Vietnamese small-and medium-sized enterprises ("SMEs") to explore the evolving relationships between the role of the State and market factors such as business support services, business training and professional development, technological and information support services and the development of SMEs in Vietnam.[139] The respondents reported shortages of good technical advisors and information, including difficulties identifying the appropriate sources for qualified information and concerns regarding the quality of technological consulting services. The respondents also highlighted a number of concerns regarding what they believe to be unclear and inadequate legal guidelines in a number of crucial areas, including property rights, patents and trademarks, technological transferring and importation of used equipment. In addition, the respondents felt that technology transfer to SMEs in Vietnam was hindered due to the lack of formal network linkages and technological cooperation among technological research institutions, between SMEs and supporting institutions, and with other firms. The respondents complained that the government had failed to articulate and implement an effective overall national technological research and development strategy. As a result, much of the technology and equipment used in Vietnam is outdated in relation to competitors in other countries in the region and the rate of investment by Vietnamese SMEs in technological innovation lags far behind similarly sized firms in India and Korea.[140] Government programs designed to incentive technological research were considered to be inappropriate for SMEs.

In the process of implementing changes necessary for it to gain admission to the World Trade Organization Vietnam substantially revised and streamlined its laws and regulations pertaining to intellectual property rights and government officials and local businesspeople recognize that strengthening intellectual property protection is essential for improving the investment environment in Vietnam. In 2013 the United States Trade Representative, while conceding that Vietnam had taken certain steps to improve its regulatory framework relating to intellectual property rights during the prior two years by passing decrees and issuing circulars to strengthen copyright protection and enforcement, maintained Vietnam's position on its Watch List and cited ongoing concerns regarding

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[138] "Vietnam Firms Overlook R&D", New Technologies (June 11, 2010), http://www.thanhniennews.com/2010/pages/20100614222033.aspx

[139] T. Nguyen, Q. Alam, D. Prajogo and A. Duong, The Importance of the State's Entrepreneurial Role, Business Support Services and Technological Assistances to the Development of Vietnamese SMEs (October 2008). The researchers explained that their findings were based on an analysis of qualitative data collected from 17 semi-structured interviewed conducted with randomly selected entrepreneurs in Ho Chi Minh City in June 2006. The focus of the data collection was identification of the effectiveness of various SME-related policies overseen by the State in Vietnam.

[140] D. Le, Businessmen, Business Entrepreneurs and Economic Reform (2006) (investment for technological innovations as a percentage of revenues among Vietnamese SMEs was just 0.2-0.3% while Indian and Korean SMEs invested 5% and 10%, respectively, of revenues on technological innovations).

piracy and sales of counterfeit goods over the Internet and the widespread availability of counterfeit goods in Vietnamese physical markets.[141]

[141] Office of the United States Trade Representative, 2013 Special 301 Report (2013), 56. The USTR also criticized the widespread occurrences of book piracy, software piracy (including on government computer systems) and cable and satellite signal theft. Id.