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OFFSHORING: THE TRANSITION FROM ECONOMIC
DRIVERS TOWARD STRATEGIC GLOBAL
PARTNERSHIP AND 24-HOUR KNOWLEDGE FACTORY

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Offshoring: The Transition From Economic Drivers Toward Strategic Global Partnership and 24-Hour Knowledge Factory

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ABSTRACT

The concept of offshoring of professional services first gained attention slightly over 25 years ago. At that time, US companies began to realize the cost-advantage of getting their computer software developed in India and other countries. The concept gained momentum with the advent of Internet and the availability of inexpensive communication technologies. Unrelated events, such as the need to address the Y2K problem, in a time-bound manner, further increased the use of computer personnel based in faraway places. Studies conducted by professional organizations, such as ACM, IEEE, and NSPE, focus on the cost and labor aspects of offshoring and its direct impact on employment opportunities in the countries involved. This paper broadens this perspective by emphasizing that the key drivers for offshoring will be strategic, not economic, over time. A formal mathematical model is presented to highlight the new trend. Further, instead of a binary model in which the work is performed in the country of the sponsoring organization or a different country, we will gradually see a new work paradigm in which the work is performed in a sequence in factories located in multiple continents of the world. Such 24-Hour Knowledge Factories can leverage factors beyond cost savings. One can employ professionals in multiple parts of the world, perform tasks at all times of the day, and bring new products and services quicker to the market. Just as the advent of multiple shifts allowed machines to be utilized round the clock leading to the benefits of the Industrial Revolution, the creation of new globally distributed workforces and global partnerships can lead to major strategic advantages for companies and countries alike.

PROLOGUE

“The idea of Citibank developing software in India makes no sense at all. Software needs to be developed by people who can meet frequently with the persons who will use the software, so that frequent interaction can occur among the concerned persons at all stages: prior to development, during development, and after development. Even if we

assume that such interaction could occur without frequent face-to-face meetings (and I don't agree with this at all), the time difference between India and the U.S. will make it impossible for the concerned persons to talk by phone. Further, Citibank has virtually no presence in India, and doing business in India is very difficult; so if computer software has to be developed in Asia, we would probably do it in the Philippines where we have significant business presence and there are trained programmers who can interact well in India. In the context of our banking business, the cost on computers is very small. We are not looking for reductions in cost; we are looking for ways to expand our banking business.”

The above opinion was conveyed by the then Vice President of Citibank, Korea, in a meeting at the corporate headquarters of Citibank in early 1980 to one of the authors (Gupta) of this paper. At that time, the latter was completing his MBA at MIT Sloan School and his doctorate in computer science. Based on his prior experience of working in India, he was trying to convince multinational companies about establishing new business endeavors in non-traditional host environments. If US is the ideal place to produce certain kinds of goods and Japan is the right place for others, then India should be a good place to develop software on the basis of its core competency of having inexpensive, highly educated, English-speaking programmers. After the above interaction with Citibank in New York, the concerned author met with the top executives of Citibank in India and the idea progressed further. While the particular author opted not to join Citibank as an employee, the idea eventually blossomed into Citibank Overseas Software Limited.

CURRENT SITUATION

With a growing labor market abroad and a challenging economic situation in US and several other developed countries, large and small firms are making the push to outsource professional services to highly skilled personnel in less expensive labor markets abroad. A Nasscom-McKinsey study cited a 34 percent increase in Indian software and services export from 2004 to 2005, from \$12.8 billion to \$17.2 billion (Nasscom-McKinsey,

2005). This study states that by 2010, the US IT and BPO offshoring market will be \$55 billion.

The current situation of reduction in costs versus loss of jobs, at least in the short-run, bears some similarity to the dilemma faced by the automotive industry in the early eighties when some of the parts began to be manufactured in lower cost countries such as Mexico. At the time, some observers perceived that too many U.S. jobs were being sent offshore, and that the impact to the U.S. economy would certainly be negative. However, a detailed analysis of that situation highlighted the danger of adopting a restrictive policy. This analysis revealed that increasing global competition required the United States automobile companies to outsource manufacturing to a certain degree, or to risk losing the world market to other countries that could produce cars cheaper and better. As Lester Thurow puts it: “There were only two long-term viable alternatives: either half the car is produced in Detroit and the other half in Mexico; or the whole car is produced in Japan. By attempting to use legislative measures to tilt the balance in favor of Detroit over Mexico, one would in fact be tilting the balance in favor of Japan (Thurow 2003).” The subsequent events have validated this assertion and the efficacy of the hybrid model.

Professional services, especially IT services such as software development and technical support, are at a similar stage, with some constituencies of the society using cost and time considerations to encourage outsourcing while other segments of the society applying pressure to maintain jobs within the U.S. Reports from leading industry groups on offshoring contain a base assumption that offshoring is a cost-driven activity. A 2006 Association of Computing Machinery (ACM) report describes opportunities for nations to benefit from offshoring due to comparative advantage but does not discuss the potential of a global workforce (Asprey 2006). The report does describe the opportunities for all nations to benefit due to economic theories of comparative advantage, however it does not discuss the opportunity to utilize a globally distributed workforce to transform the dynamic within which offshoring is conducted. Similar reports from the Institute of Electrical and Electronics Engineers (IEEE) and the National Society of Professional Engineers (NSPE) also describe offshoring in the context of cost-savings and advocate

offshoring only when talent is not available in the U.S. as well as training programs to improve talent in the U.S. (IEEE 2004).

Of the approximately \$1.45-\$1.47 of value derived from every dollar spent offshore, U.S. firms receive \$1.12-\$1.14, while foreign firms receive only 33 cents of the value (McKinsey 2003). Further, if income taxes paid by H1-B visa holders, and software and service imports by India are considered, outsourcing provides an aggregate benefit to the U.S. economy of \$16.8 billion (Endleman 2003). Another factor to be considered is that the average age of the U.S. working population is declining, and the US Census figures indicate that the U.S. will require an additional 15.6 million workers to maintain the current working population in 2015 (Economic Times 2003).

The 24-Hour Knowledge Factory concept described at the end of this paper broadens the view of offshoring from a cost-savings exercise to a strategic optimization of globally distributed workforce. We describe a framework for transforming to a strategic global partnership and employing a 24-Hour model of continuous work on knowledge-based deliverables.

POLITICAL PERSPECTIVE

In November 2003, Governor Joe Kernan of Indiana canceled a \$15.2 million contract with Tata America International Corp., a New York-based subsidiary of Tata Consultancy Services (TCS). The Tata entity had won the contract over competing bids from Accenture LLP and Deloitte Consulting LP; its own proposal was \$8.1 million to \$23.3 million less than those of its competitors.

The late Governor Frank O'Bannon had approved the contract before his death in September 2003. Up to 65 contract employees were stipulated to work alongside 18 state workers. All work was to be done at the Indiana Government Center, but the selected vendor was free to bring in additional workers from anywhere and pay them as it deemed fit. No Indiana-based companies had submitted proposals. Governor Kernan stressed that

his decision to cancel the contract did not reflect on the ability of TCS to complete the job or any other shortcomings.

Stuart Anderson of the National Foundation for American Policy and Cesar V. Conda, former domestic policy adviser for Vice President Cheney, highlight the fact that the impact of this reversal on Indiana taxpayers will be very significant (Anderson 2003). In this case, the next lowest bidder was \$8.1 million more than Tata's bid. Since the contract involved about 65 employees and since TCS was obligated to retain the existing Indiana workers, choosing a U.S. firm would impact a maximum of about 50 jobs. Assuming the extreme scenario that all these 50 jobs would now go to residents of Indiana, this still implies that the taxpayers of Indiana will now bear a cost \$162,500 per new employee - a cost that most taxpayers would probably be unwilling to pay. Furthermore, as Anderson and Conda point out, by limiting the bidding to in-state contractors, policy-makers are ignoring the economic principle of comparative advantage, and increasing the cost of future contracts since there will be fewer competitors.

Contrast this with a parallel development in the city of Springfield, Massachusetts. Its mayor decided that all drugs for city employees would henceforth be bought in Canada where the prevailing prices are between one-fifth to one-half of the comparable prices in the US. This would save the city millions of dollars each year. This aspect acquires special importance under the current economic conditions when many state and local governments are facing significant financial problems.

Bills proposed over the recent years at the federal and state levels in the US have attempted to use the government's authority in granting H1-B and L1 visas to combat companies who had replaced American jobs with offshore workers (Nanda 2003). These bills were considered even though a GAO report had stated that more study was required to determine the true effects of the H1-B visa program on the American workforce, and the impact cannot yet be fully understood (US GAO 2003).

Several states in the US have pending bills that would prevent the outsourcing of government IT jobs to abroad. Other bills would require call center employees to identify themselves by their real name and the location they are based in (thereby discouraging outsourcing of technical support and other types of customer support). Many of the pending bills seek to use the power of government contracts to curb outsourcing. The proposed pieces of legislation usually fail to consider the long-term impact on citizens, both shareholders and taxpayers. For example, keeping IT jobs in the United States is likely to be more expensive, and these costs ultimately will be transferred to citizens, either in the form of increased taxes or reduced corporate dividends.

The proposed legislative actions are gaining attention and are partially fueled by the desire to capture the attention of the unemployed persons. While these proposed laws might offer some short-term benefits to some persons, they fail to consider the long-term impact on the broader population or present the full picture to the electorate. For example, if one asks the voters to choose between retaining 1000 jobs in a particular state or letting them go abroad, virtually all voters would opt for the former option. What happens if one asks a more relevant question: “Do you prefer that 1000 jobs stay in the state or do you prefer a tax reduction of \$150 per year?” the latter benefit would occur if these jobs are permitted to go outside the state.” In this case, many voters may opt for the reduction in their taxes, even if the two numbers were different from these hypothetical numbers for their respective states

From a labor perspective, most professional service workers are not unionized, though several observers have cited this possibility as being a likely trend, especially in the software industry. Groups such as the IBM union and the Seattle union represent the rights of a subset of software workers and advocate leaving American jobs in America. If an increasing number of professional workers enroll in unions, the new labor unions may impact the larger political landscape and alter the existing balance between management and labor.

In order to mitigate the types of pressures described above, one needs to think of new hybrid work paradigms that yield the best cost performance ratios by having part of the work performed in the US and other parts abroad.

TECHNOLOGICAL PERSPECTIVE

A survey of over 50 software executives participating in off-shoring concluded that “off-shoring will live or die based on the ability of everyone involved to communicate with each other.” (Sand Hill 2003) Richer collaboration technologies need to become available in order to enable simultaneous use of video, audio and other messaging capabilities to link geographically and temporally separated personnel. The outsourcing of professional services requires firms to transfer knowledge via formal and informal channels within their organizations, as well as to establish and preserve knowledge repositories both for offshore teams to come up to speed on new tasks and for onshore teams to learn what is being done offshore. Such efforts require deep understanding of evolving technology and business needs.

A Merrill Lynch report concludes that India is the most preferred destination for outsourcing (Subramanian 2002). The key is to educate the concerned individuals both on the opportunities as well as on the process, and to use technology to develop an understanding of what is best done in the US and what is best done offshore. The delineation of what components of jobs should be performed in developed versus developing environments requires an intimate appreciation of the cultural and social issues such as language and education; this also involves understanding the technical requirements of each type of job. Certain jobs that are communications intensive, or have significant hardware or infrastructure requirements, may be more suited for one location versus another. As countries begin to appreciate this aspect, they may make critical investments in nurturing new technologies to support emerging market needs. Plambeck and Taylor’s model of original equipment manufacturers (OEMs) pooling capacity with other OEMs, as opposed to using contract manufacturers (CMs), in an effort to invest in innovation (Plambeck 2001), could be used to demonstrate the importance of integrating the various phases of the design and development process in industries such as software.

NATIONAL POLICY CHALLENGES IN A GLOBAL ECONOMY

The potential distribution of work across geographic and temporal boundaries requires careful delineation of the economic ramifications of alternative distribution models in order to elicit the optimal benefits from the outsourced model. While some lessons can be learned from the experiences of globalization in manufacturing industries, the inherent distributed nature of the new paradigm presents new challenges.

In testimony before the U.S. House of Representatives Committee on Small Business, Assistant Secretary for Technology Policy Bruce Mehlman has cited the United States policy strategy to be based on an investment in education, infrastructure, innovation, and to highlight existing benefits such as intellectual property protection (Mehlman 2003). Such a strategy suggests that the most sustainable model will be to prepare U.S. professional service workers to perform higher level tasks and allow tasks which require less education, training and infrastructure to be performed abroad. Rather than use these strategies to build a legislative wall around the United States, tasks will be performed much more efficiently because the U.S. engineers will be equipped to handle the more specialized parts of the shared onshore-offshore projects.

The benefits of onshore and offshore engagements, as reported by the U.S. Department of Commerce Office of Technology Policy after convening business, university and government leaders are summarized in the following table (Mehlman 2003):

| | Onshore Benefits | Offshore Benefits |
|-----------------------|---|--|
| People | Talent pool is unmatched | Untapped talent pool |
| Business Climate | Entrepreneurial, market-based, easy access to capital | Less burdensome taxation, regulation, litigation |
| Infrastructure | Telecom, energy, transport | New global clusters created |
| Market Access | Innovation in largest market | Untapped markets |
| Intellectual Property | Commitment to patents | |
| Government | Political stability | |
| Quality of Life | Freedom, health care, | |

| | | |
|----------------------------|-----------------------|------------------------------|
| | security, environment | |
| Cost | | Talent, facilities cost less |
| Proximity to manufacturing | | Plants are already offshore |

The report of the U.S. Department of Commerce entitled “Education and Training for the Information Technology Workforce” states that IT employers are looking for a specific blend of technical and business skills, and that they prioritize a minimal amount of training (Mearns 2003). This notion of flexible training that will allow workers to succeed in a changing marketplace for professional services is useful in determining the strategic direction for both onshore and offshore firms.

In outsourcing of professional services, the set of relevant stakeholders involves include parties from both developed and developing nations. Now, companies in developing nations themselves are beginning to outsource to other markets to spread their labor costs. Another emerging issue relates to the digital divide created by enclaves of digitally enabled citizens benefiting from the outsourced opportunities living in close proximity to much poorer fellow citizens. The disparity in living standards creates potential political, social and organizational risks. This is a matter of concern for governments of developing nations hosting the outsourced contracts; it is also a matter of concern for governments of nations such as the U.S. that are witnessing increasing invested in regions over which they have little control. Based on the latter concern, it may be in the interest of the U.S. government and industry to invest in the educational and economic improvement of developing nations. But this is a tough politically sustainable strategy since the apparent goal of such investment would be to provide more opportunities for foreign workers to acquire U.S. jobs.

The table below summarizes the key stakeholders:

| Outsourcing Nations | Host Nations |
|--|--|
| Professional service workers losing jobs | Professional service workers being hired |
| Firms hiring foreign labor | Firms providing outsourcing service |
| Legislators responsible for economy | Policy makers responsible for economy |

| | |
|------------------------------------|--|
| Regulators | Citizens not being hired for professional services |
| Government procurement | |
| Customers of professional services | |

The relationship between these stakeholders is complex. On one side, we have the workers and the need to retain professional service jobs remain within the United States; on the other, we have significant cost savings accruing to the firms who are hiring the foreign labor. Long-term solutions such as better education, better infrastructure, and better intellectual property protection, as suggested by Mehlman, are irrelevant in the short-term in terms of their ability to resolve the issues faced by these stakeholders.

CREATING NEW STRATEGIC GLOBAL PARTNERSHIPS

The sustainability of offshore outsourcing practices depends critically on their ability to satisfy the needs of the stakeholders, from the dual perspectives of the offshorer and the offshoree. Emotive debates apart, dispassionate academic studies focusing on this global phenomenon have been limited. This paper focuses on organization-level profitability resulting from offshoring activities, with respect to the complexity of the tasks that are offshored. Based on insights from the literature and real-world experiences, an analytical model is created; the model demonstrates that offshoring of complex and strategic tasks can result in increased profitability and larger market share, compared to offshoring of simpler and more tactical tasks. The evolution of the the business model and process capability is becoming of the mechanism for achieving strategic advantage in offshoring (Athreye 2005). Indian firms especially are found to be moving up the value chain into strategic partnerships (Arora 2000). These findings indicate that to reap the full benefits from offshoring and to develop sustainable models, one need to treat offshore vendors as strategic partners rather than as mere low cost service providers.

Building on the Foundation of Offshoring: The global phenomenon of offshoring refers to ‘offshore in-sourcing’ (where an organization moves parts of its operations to offshore locations) or ‘offshore outsourcing’ (where an organization assigns specific jobs or projects to other offshore companies). Offshoring can be studied at three levels: micro or

individual level; meso or organizational level; and macro or national and global level. While debates concerning micro and macro levels frequently garner significant visibility in the media, this section of the paper focuses on the organization (meso) level and proposes an analytical model to understand how the complexity of the offshored tasks relates to the sustainability of the offshoring model.

While there is a general understanding that organizations typically outsource non-core activities in order to gain from labor arbitrage, evidence from research suggests that it is often more profitable, from the client perspective, to outsource projects that are more complex and strategic in nature (Gopal et al. 2003). As such, there is need to develop a long-term partnership between the client and the vendor/service provider, instead of maintaining an arms length contractual relationship between them (Choudhury and Sabherwal, 2003; Kishore et al. 2003). The performance of more strategic services translates into greater revenue and greater ‘customer-stickiness’ for the vendor (and hence, lesser associated risks); in addition, there is evidence that more strategic projects yields greater profitability for the client, and results in a win-win relationship that is sustainable on a long run basis (Plambeck and Taylor, 2001). (Cachon and Harker 2002) argue that by leveraging scale economies, outsourcing contracts can create economic value, both for the client and the vendor, even in the absence of other cost benefits. Accordingly, the outsourcing argument seem to be transiting from pure ‘cost savings from labor arbitrage’ to that of ‘value creation through leveraging of resources’ - a more sustainable proposition, only if clients and vendors are prepared to get into a strategic, long term relationship.

Our real-world experiences seem to validate the above. One of the authors (Ganguly) was employed with a couple of companies in the US where he witnessed offshoring of simple and tactical tasks as well as complex and strategic tasks. The first company was a giant software vendor specializing in database and enterprise-scale applications development, and the author oversaw offshoring of simple, tactical tasks in the area of demand planning software to the company’s Indian subsidiary; the offshoring of relatively simpler tasks led to nominal returns on investments, and the offshore unit was treated as

mere low-cost service provider. The second company was a venture-backed niche software vendor in demand planning and related areas, and the author oversaw offshoring of strategic, complex tasks to the company's unit in Israel; the strategic relationship facilitated disparate skills to be leveraged, almost round the clock, in an efficient and cost-effective manner, and the employees of the offshore unit to be treated at par in terms of benefits and remunerations, after allowing for currency and living cost differentials.

Oracle Corporation's Indian subsidiary initially performed 'low-end' routine tasks like maintenance of legacy applications; gradually, it became an integral part of team involved in developing Universal Server- Oracle's flagship database product. The migration paths of 'foreign factories' to higher strategic roles have been documented in cases of Motorola's Singapore pager unit, Alcatel Bell's unit in Shanghai, 3M's operations in Bangalore, India and HP subsidiary in Guadalajara, Mexico (Ferdows, 1997).

ANALYTICAL MODEL TO GUIDE TRANSITION TO STRATEGIC PARTNERSHIPS

In this section, an analytical model is developed, based on previous work of two of the authors (Mukherji and Ganguly, 2004), to study the impact of offshoring specifically with respect to the complexity and strategic nature of the tasks offshored. This is done in two steps. First, the impact of project complexity on profitability is considered by developing a 'two-country model'. This is followed with a 'decision model' that incorporates project complexity and time duration of relationship as determinants of cost savings and risk-perception. The underlying assumptions in the analytical formulations are illustrated in Figures 1 and 2, and described in the following paragraphs.

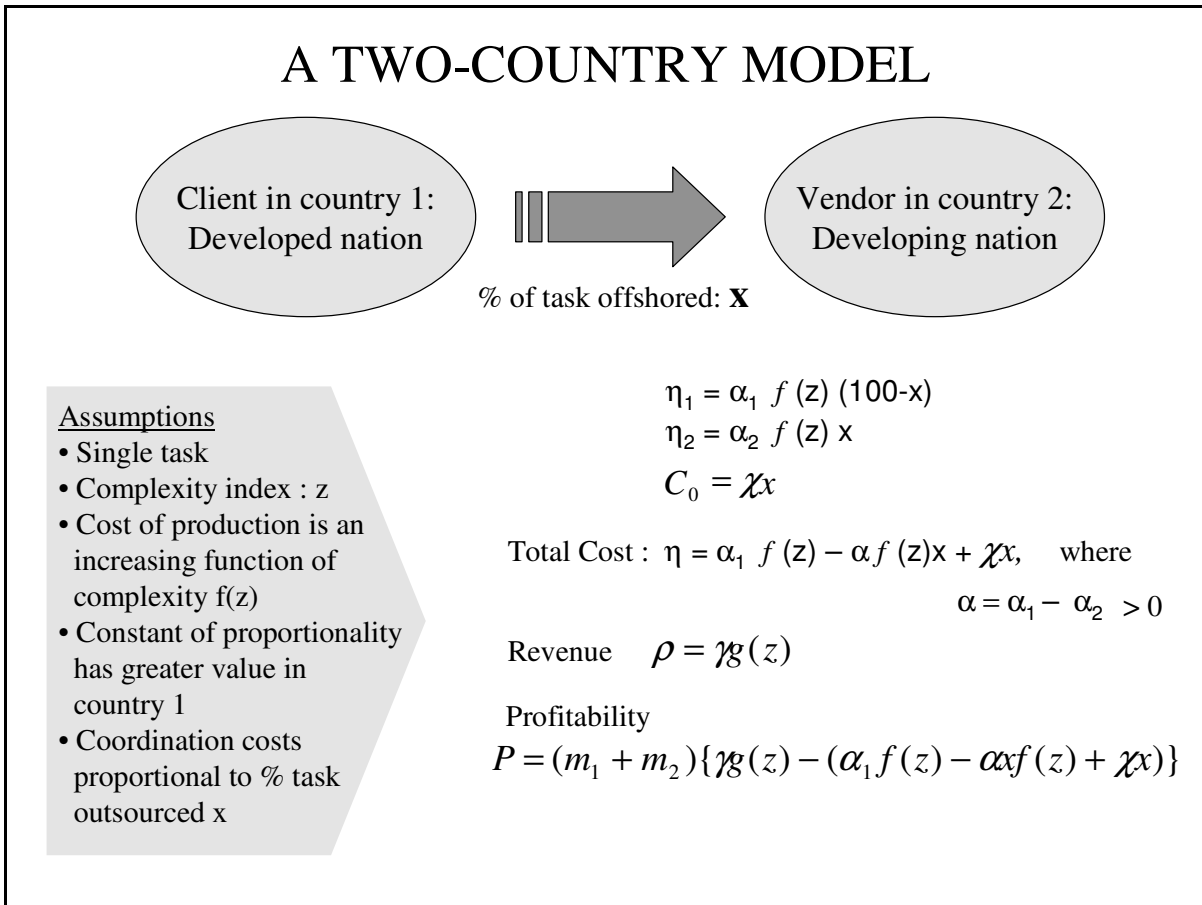


Fig 1: A two-country model

The traditional wisdom in offshoring is that vendors prefer to execute complex projects while clients prefer to offshore outsource simpler projects. The preference of the vendors stem from a desire to “move up the value chain” and to facilitate retention of employees with higher levels of core competence. The perspective of the clients is dominated by factors like the minimization of downside losses, the perception that cost benefits are maximal from offshoring simple tasks, possible compromise on product quality and the lack of “end user” interactions of the vendors. The two-country model explores the traditional wisdom based on a grossly simplified, but nonetheless interesting, analytical formulation.

COMBINING COST SAVINGS WITH RISK PERCEPTIONS: GRAPHICAL REPRESENTATION

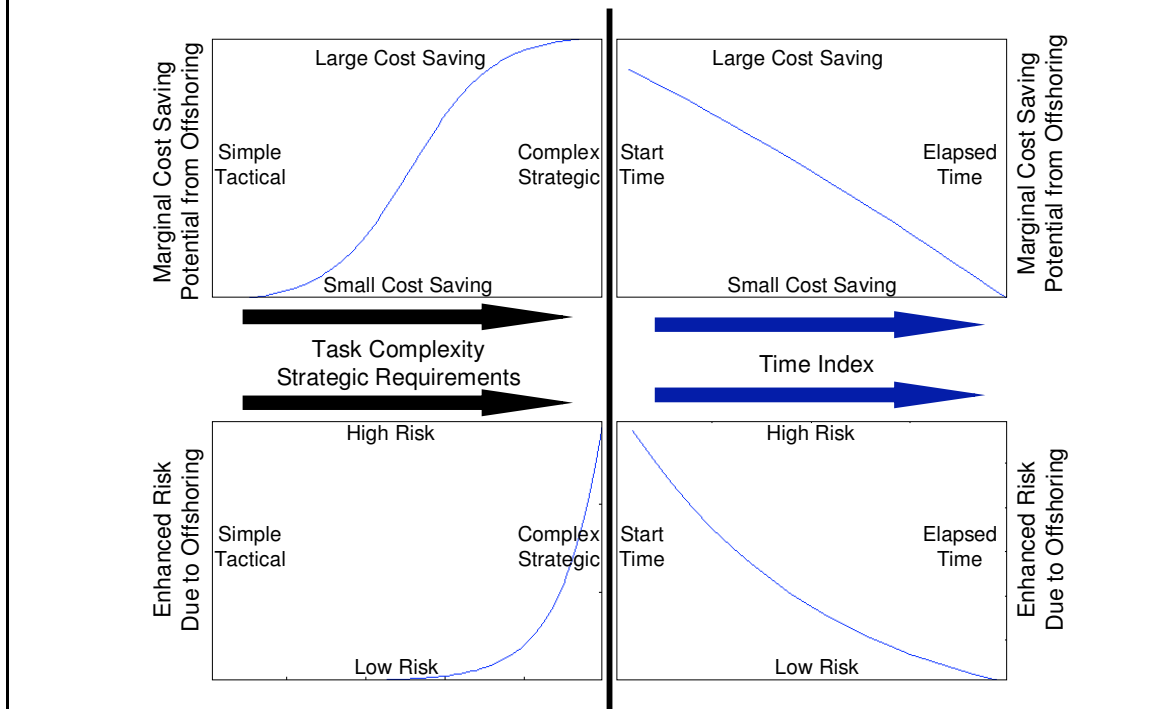


Fig 2: A decision model

Real life outsourcing decisions can be modeled as a trade-off between cost savings and enhanced risks. Both of these are functions of the strategic nature of the project or the project complexity and the duration of relationship between client and the vendor. The simplified decision model presented here rests on four key hypotheses about the nature of the offshoring processes: (i) Marginal costs savings from outsourcing increase with the complexity of tasks; the saving from simple tasks is small, it increases linearly with complexity and approaches a limit; (ii) Marginal cost savings from outsourcing for a given task decrease with time; (iii) The perceived risks of outsourcing increase rapidly with the complexity or strategic nature of the tasks; and (iv) The perceived risks of outsourcing, for a given task, decrease rapidly with time.

Fig. 1 depicts the two-country model. It considers a single task, of which $x\%$ is offshored, and for which a complexity index (z) can be defined depending upon the complex and strategic nature of the task. The costs of production are assumed to be constantly proportional to an increasing function of complexity, $f(z)$, with the constant of proportionality having a higher value in the country from where the project is offshored. The coordination task is assumed to be proportional to the percent of the task offshored. These lead to:

$$\eta_1 = \alpha_1 f(z) \quad (1a)$$

$$\eta_2 = \alpha_2 f(z) \quad (1b)$$

$$C_0 = \chi x \quad (1c)$$

$$\eta = \alpha_1 f(z) - \alpha_2 f(z) + \chi x \quad (1d)$$

In (1d), η is the total unit production cost, and α is the difference in the constants of proportionality, reflecting the currency and other cost differentials. An implicit assumption of the model is that the dependence of the coordination cost on the complexity of the tasks offshored is considerable weaker than the dependence of the production costs on complexity.

For constant market size assumption, we obtain the following set of equations:

$$\text{Unit revenue } \rho = \gamma g(z) \quad (2a)$$

$$\text{Profit } P = (m_1 + m_2) \{ \gamma g(z) - (\alpha_1 f(z) - \alpha_2 f(z) + \chi x) \} \quad (2b)$$

The unit revenue is also assumed to be proportional to an increasing function of the complexity (or strategic nature) of the product. Note that we assume for simplicity that the unit revenue is identical for the same task in the two markets (even though the market sizes for the task might differ), and obtain an expression for profit of the organization. Profit is differentiated with respect to the percent offshored x to understand the unit gain from offshoring, and differentiated once more with respect to the complexity index z to obtain the change in the unit gain as a function of the complexity of the task. Thus, we obtain:

$$P_x = \partial P / \partial x = (m_1 + m_2)(\alpha f(z) - \chi) \quad (3a)$$

$$\partial P_x / \partial z = (m_1 + m_2)[\alpha f'(z)] \quad (3b)$$

The right-hand side of (3a) is positive as long as the cost reduction due to offshoring of a portion of the task from country 1 to country 2 exceeds the cost of coordination a prerequisite for the offshoring to be initiated. The simple model results in increasing profits with the percent offshored. The change in the profit with change in unit offshored is itself an increasing function of the complexity, as seen from (3b). Since $f(z)$ is an increasing function of z , $f'(z)$ is positive.

Similar calculations can be made for constant margin and linear price elastic market assumptions. There, the first differential yields market share as an increasing function of percentage outsourced x , and the second differential shows market share per unit increase in percentage offshored as an increasing function of complexity.

Decision Model: In real life decision making situations, the benefits of cost savings is likely to be deflated by perceptions of risks. Thus, we develop a decision model, outlined in Fig. 2 that incorporates potential cost savings, as well as the risk potential, from offshoring activities, as a function of time. The model comprises of the following assumptions:

1. The marginal cost saving potential due to offshoring, as a function of the degree of complexity (or strategic nature) of the tasks for a single time period, can be represented in the form of a logistic, as shown in the top left of Fig. 1. This implies that the cost saving potential from tactical and simple tasks is small (asymptotically approaching zero); then as tasks get more complex or strategic, the cost saving potential increases linearly with the degree of complexity, and finally beyond a certain level of complexity, the cost saving asymptotically approaches a limit.
2. The enhanced risk from offshoring, as a function of the degree of complexity of the task offshored for a single time period, can be represented as an exponential function, as shown in the bottom left of Fig. 2. This implies that risks increase exponentially with the complexity or strategic nature of the tasks offshored.
3. The cost saving potential from offshoring, for a given task, decreases with time in a near linear fashion, with a small slope, as shown in the top right portion of Fig. 2. The

functional form used there is the exponential asymptotic function, which starts from an asymptotic limit, decays almost linearly, and then asymptotically approaches a smaller limit.

4. The enhanced risk from offshoring, for a given task, decreases with time in an exponential fashion, as shown in the bottom right portion of Fig. 2.

The curves assumed in this formulation are based on dual considerations of intuitive business sense and ease of analytical manipulation. The basic shapes can be justified from the insights obtained earlier from the literature review section. However, the conclusions presented here are generalizable to more complex curves. Further, the parameters of the curves can be changed to adjust the relative scales.

The decision model considers two decision parameters that indicate the desirability, in terms of offshoring for the organization of any given type of task, as measured by the complexity index at any given time. The first decision parameter computes the decision function as a time-varying combination of the risk potential and the cost saving, where the risk potential is weighed more heavily during initial stages, i.e., when the client-vendor experience is low, but getting less weight with time. The second computes the decision function as a time-invariant function of the cost savings and risks.

Figures 3 and 4 show the decision variables (higher values of these variables indicate desirability of offshoring) as a function of the complexity of the tasks and the time elapsed.

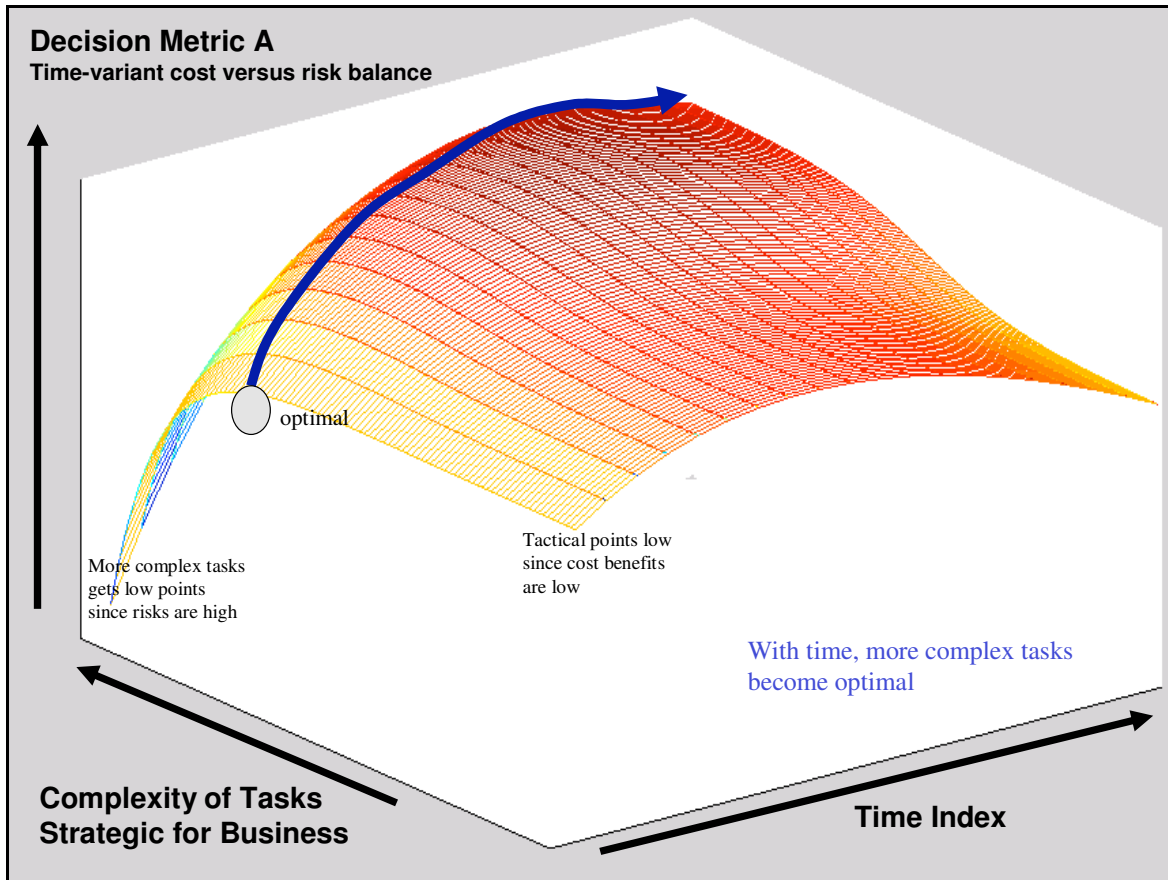


Fig 3: Time-variant decision variable

The decision model considers two decision parameters to arrive at desirability of outsourcing of a given task. Additive formulations have been used for the simulations, after normalization. Higher values of decision variable indicate desirability of offshoring. Here the decision metric corresponding to a time-varying function has been displayed. This function allows the risk potential to have higher weights initially caused by managerial perceptions. The decision metric shows that during the initiation of the offshoring process, complex tasks are low in the list of priorities to be offshored since the perceived or real risks are higher. The extremely simple or tactical tasks have low values initially as well caused by the lower cost benefits. The presence of an optimal task complexity is therefore a possibility even during the early phases of offshoring. This is demonstrated through the decision metric at low values of the time index. However, as the time index moves forward and the offshoring processes mature, the decision metric

clearly demonstrates that the desirability of offshoring the more complex or strategic tasks increases.

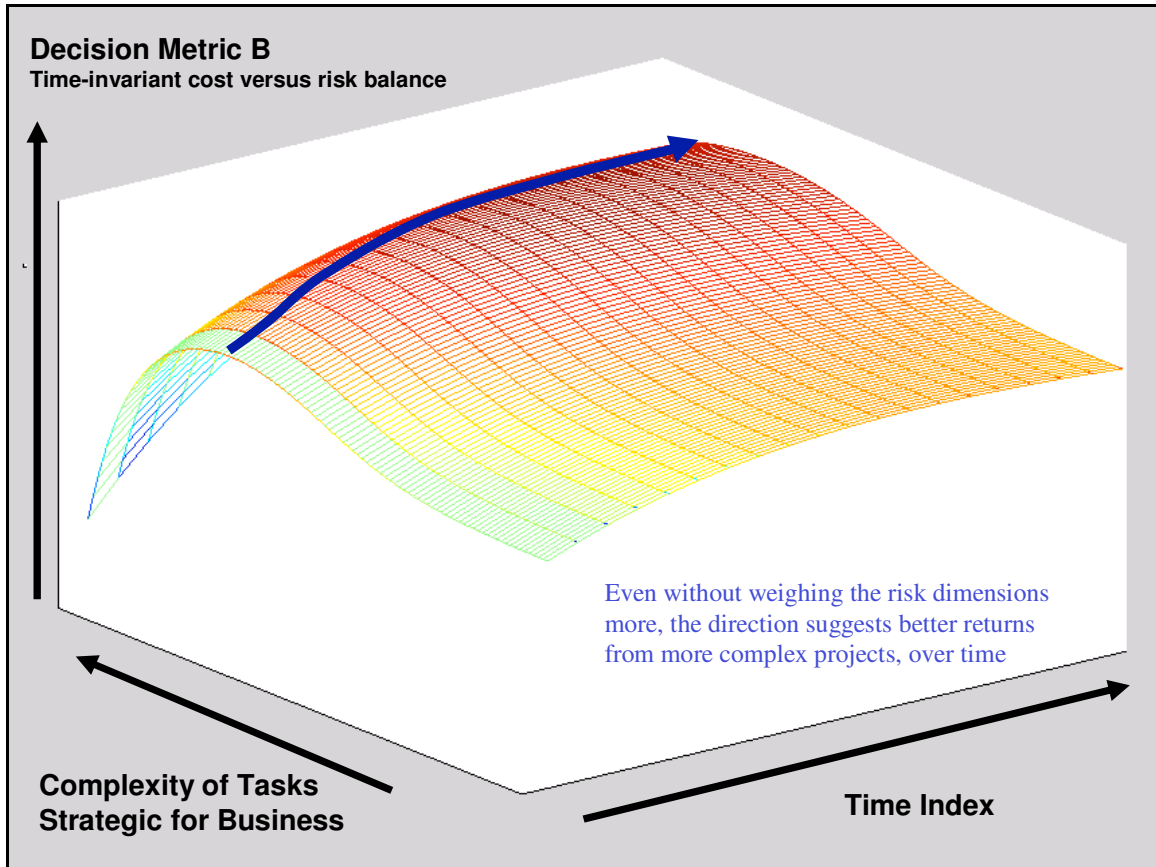


Fig 4: Time-invariant decision variable

Figure 4 is similar to Fig. 3, with the exception that the decision metric corresponding to a time-invariant function has been displayed here. This function keeps the risk potential constant over time to emphasize the influence of other variables. The decision metric demonstrates that even without weighing the risk dimension more over time, the desirability of offshoring the more complex or strategic tasks increases.

The results from our analytical model, as seen from Figures 3 and 4, indicate that with elapsed time (i.e., more client-vendor experience), offshoring more complex and strategic projects become more desirable. Initially, the decision variable does not appear to optimally favor either the most strategic or the most tactical task, but a balance that is dictated by the nature of the curves (and parameters) selected. However, with time and experience, strategic tasks are increasingly favored.

Completion of Transition to Strategic Partnership: The simulations suggest the possibility that, contrary to common wisdom in some quarters, but perhaps in line with what some experts/academicians have said, one might be able to get significant value out of offshoring tasks that are not just tactical or "simple" in nature. The possibility of an "optimal" level of complexity that maximizes the return from offshoring, at any given time period or experience level, under given situations is also suggested, within the constraint of our assumptions. In addition, the simulations indicate that the offshoring of more strategic tasks leads to higher profitability and sustainability. Accordingly, both the client and the vendor need to reinforce their efforts to explore how tasks of strategic nature can be identified and selected for offshoring, and how closer ties can be established over time between the vendor and the client.

We emphasize that the managerial insights from this study are dependent on the validity of the assumptions. An interesting line of future research would be to explore the offshoring strategies from a game theoretic perspective, where clients and vendors, as well as offshoring and offshore nations with their respective legislative bodies, are the key players. We hypothesize, without proof, the possibility of Nash-like equilibria, where the equilibrium points shift from tactical to strategic partnerships as the offshoring processes mature. The maturity of the offshoring process needs to be modeled and quantified both in terms of the tactical client-vendor relationships and in terms of strategic perceptions among the stakeholders. Advances in communication technologies and the ubiquity of the Internet, as well as the breaking of traditional cultural and

linguistic barriers, are key issues influencing the maturity of the tactical client-vendor relationships. The maturity of strategic perceptions will depend on various geo-political, economic, cultural and social considerations. The concept of the 24-hour knowledge factory has the potential of influencing both the tactical relationships and the strategic perceptions.

CONCEPT OF 24-HOUR KNOWLEDGE FACTORY

The 24-Hour Knowledge Factory attempts to establish a virtually seamless relationship between the vendor and the client; this may involve one organization in a developed country as one entity, and two or more organizational entities located in other continents. The paradigm includes situations where all the collaborating entities are part of one large organization, such as IBM or Oracle. In such a model, a global team is used to work on a project around the clock; each member of the team works the normal workday hours that pertain to his or her time zone and transfers work nightly to others on the team. The 24-Hour Knowledge Factory paradigm can be applied to a broad range of white collar activities ranging from medical services to logistics planning, and from financial analysis to product design.

The notion of the 24-hour Knowledge Factory builds on the shift-style factory model developed in the Industrial Revolution. Given limitations on equipment, shifts were used to optimize the productivity realized from a given set of machines. The advent of the internet led to a similar notion that individuals working at different times could operate on the same work product – call centers are an early example. Now, it is possible to extend this model to any environment where work is primarily knowledge-based and can be passed among team members on a nightly basis.

The 24-hour Knowledge Factory will involve “offshoring” of part of the endeavor. Today, offshoring is done mainly to reduce costs as discussed in preceding sections of this paper. Over time, the growth in offshoring will be fueled more by the potential to achieve drastic reductions in turnaround times for major endeavors, as depicted in Figure 5.

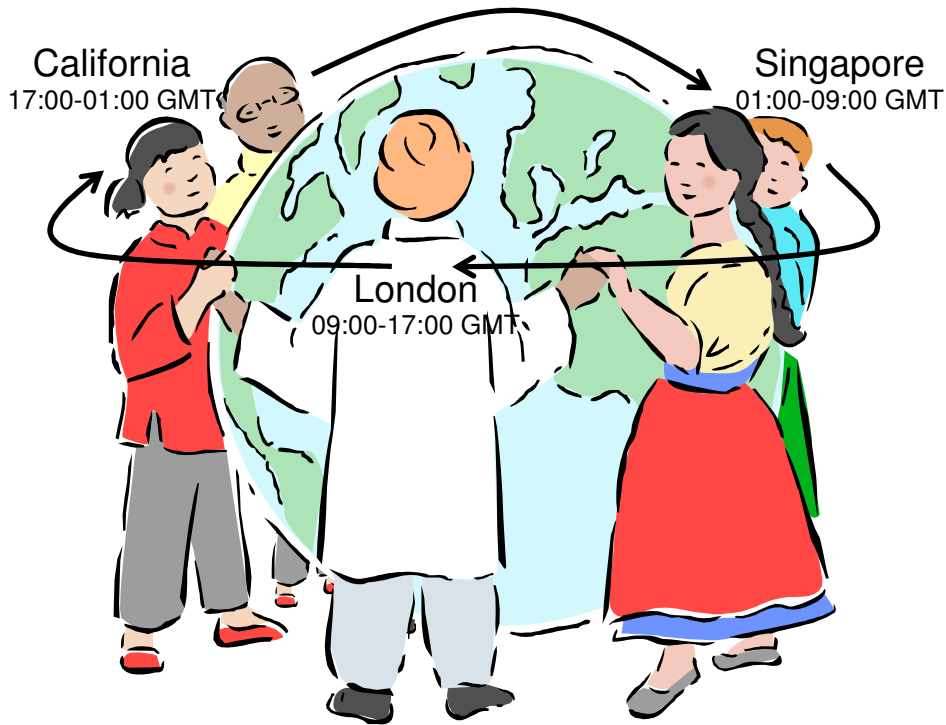


Figure 5: 24-hour global knowledge factory

In a "24-hour development environment" that encompasses three or more development centers located around the world, the distributed team is envisaged to concentrate on the same problem and to perform the same function (whether it be development of code or testing of subsystem) on a successive basis, with each collaborating center retaining ownership of the endeavor for 8-hour periods in every 24-hour cycle. A large number of industries, including the software industry, are characterized by a development cycle that relies heavily on sequential performance of specific functions, such as development, testing, and verification. In a traditional software development environment where all parties are located in the same geographic area, a code developer typically waits until a fully functional portion of the product is available before passing it on to an engineer to test it. However, with the potential for receiving testing feedback overnight, the developer now has the unprecedented opportunity to build portions of the product on an incremental basis.

serve customer demand and provide for 24 hour availability of high value resources (Suh 2004). One example of the latter phenomenon is a company that employs home-based workers in India to perform medical transcription. As these workers move up the value chain, their home-based work environment continues to allow them to be readily accessible. Accordingly, these workers can work longer hours, as necessary, concurrently with family obligations at home, thereby serving as ‘agile’ knowledge workers in the knowledge factory in real-time (Malhotra 2004).

Long-term Productivity: The use of hybrid work models can provide access to higher skilled labor for tasks that previously only were done by lower skilled workers. For example, highly skilled radiologists in the United States are much less likely to prefer reading X-ray results while in India, a highly skilled radiologist will see employment by a U.S. hospital as a high-value position regardless of the task. When moving toward a 24 hour knowledge factory model, factors such as ability to grow in size, quality management, and the added communication and coordination costs must be incorporated into the calculation of the improved productivity (Shah 2004).

Integrated Value Chain: The application of the 24-hour Knowledge Factory paradigm explicitly implies partial offshoring. While the initial effects of such offshoring will be an increase in productivity, the offshore workers will gradually move up the value-chain and provide a great deal of higher-value services. According to Accenture, for IT offshoring, 51.9% is in IT services such as maintaining computer networks, 36.7% is in solutions development such as building websites and 11.4% is in leadership and managing projects (Christensen 2001). The general progression can be characterized as a movement from efficiency to innovation to growth, with production moving from commodities to services to solutions, as vendors begin to do similar work for multiple customers (Barney 1999). The movement up the value chain is not reserved simply for the offshore workers, as in the example of radiology, US doctors can move to higher value tasks if X-Ray reading is done offshore.

Organizational Models: In order to maintain flexibility, one needs dynamic models that can evolve as market conditions change and learning curves impact skill levels. In choosing a model, it is important to judge the complexity of the work required and determine the right locations for each particular skill required (Christensen 2001). This may lead to a model where the same function or skill is located in multiple geographic locations; this may involve higher management overhead but may lead to greater returns especially when taken in the context of the 24-hour knowledge factory. Two matrices upon which the organizational models can be judged are coordination versus effort, and complexity versus project size (Barney 1999).

Barriers within Firm: Significant barriers to employing the 24-hour knowledge factory concept exist within typical firms; several of them need to be addressed as part of the initial decision process rather than as a corrective measure at a subsequent stage. Internal resistance, especially due to a loss of control, may hinder a proposed project. Furthermore, cultural, language and trust issues need to be approached in an upfront manner, recognizing the impact with respect to the interaction required between knowledge workers in the 24 hour knowledge factory. Even if the desire exists at all levels to pursue the globally collaborative engagement, the firm should plan on process changes such as longer project planning cycles, more explicit definition of requirements and communication methods and the effects of ill-informed hiring decisions.

Location Choice: Different geopolitical locations possess their own characteristics that impact their current and future place on the value chain. For example, China has lagged behind India in knowledge-based offshoring because of a lack of English speaking citizens, but as English becomes a more common language in China, the vast size of the labor pool will allow it to rapidly move up the value chain (Baxter 2004). In Russia, highly skilled scientists and engineers saw a dramatic drop in high skill tasks after the Cold War; these domain experts are now making a dramatic transition into high-value services such as optics design at a much lower cost to outsourcing firms (DiRomualdo 1998). The hiring process is a major factor in moving firms up the value chain, as a constant reevaluation is required of whether the foreign employees are indeed the highest

skilled in their area (Andre 2004) Regardless of the locations being considered, factors to consider include the geopolitical stability of the country, the investment in education, labor and skill set of citizens, and the business environment in the country, including levels of corruption and ease of setting up businesses (Lacity 1995).

CASE STUDY AT IBM INVOLVING TWO PARALLEL WORK TEAMS

Two teams of workers at IBM were studied to provide an example of the relative pros and cons of the 24-hour knowledge factory model. While the two teams were equal in all relevant structural and technical respects, one team was geographically separated between the US and India while the other was collocated on the same hallway in the US. A one year timeframe was used to cover the entire lifecycle of the teams' software deliverable. Whereas the overall performance was found to be very similar in the two cases, there were interesting differences at the micro level.

Specific forms of data were collected and analyzed, as follows:

Personal interviews were conducted with each of the developers on each team, for both qualitative and quantitative insight. Developers were asked about frequency of informal versus formal interaction, percent time spent in various communication vehicles (phone, instant messaging, and face to face), the number of tactical versus strategic decisions made informally, and which specific developers involved interactions.

Software Problem Reports (SPR) were process forms used to track fixes or requests to change the code. Weekly analysis of these SPRs provided insight into the reliance on structured forms for knowledge tracking and daily communication, average time to resolution of issues, and the number of developers handling each issue.

Weekly Meeting Minutes were analyzed with a coding system for strategic versus tactical task assignments and status requests. This provided insight into formal knowledge sharing on a group-wide basis for each team.

The **Source Code Control System** was used by each team to log the modifications made to each element of the source code for the team's product. The source control system stores the date, the time, the name of the developer making the change, and a comment regarding the particular change. The data provide a representation of the technical dependencies between developers on the teams by looking at number of developers interacting with each code element, and the rate of technical collaboration within the teams by looking at the number of logged modifications.

Group Email Exchanges were analyzed with a software tool that calculated statistics on individual messages and "threads" containing a set of messages written in response to an initial message. The data collected involved frequency of messages, number of messages per thread, and number of developers per thread.

Use of Electronic Mail for Asynchronous Discussion

The data revealed that the distributed team made much greater use of electronic mail (e-mail) as a forum for discussion. This usage peaked during the time periods following project deadlines and was relatively constant in the periods of steady work well before the milestone. The collocated team relied on e-mail as an announcement mechanism for broadcasting a message to the general set of developers, but relied on other means for back and forth discussion. The e-mails which were tabulated for each week of the year, and only those emails which were sent to the entire group were tabulated.

Overall, e-mail was used as a means for extended discussion on the distributed team, while it is primarily used for one message announcements on the collocated team. A developer on the collocated team stated that many of the one message announcements from the collocated team are announcements that a particular individual is heading out of the office, even for a period of just an hour. This demonstrates a significant difference in team culture on both teams. On the collocated team, face to face discussion is so important that team members feel the need to inform each other if they are going to be unavailable for a short period of time. On the distributed team, long discussions are done over e-mail and often last days because of the time zone differences. A developer on the

distributed team cited one of the benefits of having discussions done over e-mail is that team members can take the time to think about their responses and often provide more detailed input into the discussion. The members of the distributed team also stated that when discussions reach a significant length, they are moved to a discussion forum database where responses can be better tracked and archived. When reviewing the design of a feature to be included in a product release, it was common for the U.S. portion of the team to hold a meeting with a presentation to discuss the design. Later that day, after the U.S. work day was complete, the Indian portion of the team would review the slides from the presentation, and provide feedback in an organized and written manner. Both forms of feedback – immediate face to face and asynchronous written – were useful in the end product and neither would have been achieved if operating in the other framework. The setting of ground rules was acknowledged by all team members as an important factor in both overcoming cultural differences and encouraging uses of the different technologies discussed in this study. The manager of both teams stated that the discussion forum database is common to both teams; however, the distributed team is more prone to use it. This is a likely result of the distributed team's familiarity with having to carry out discussions by typing their responses in e-mail format.

The collocated team had more e-mail threads created, but many of these threads had just one contributor. The distributed team had less number of threads, but with a high degree of collaboration on each thread. This confirmed the anecdotal evidence from the interviews that the nature of e-mail use and the nature of knowledge based discussions on both teams is profoundly different.

Technical Collaboration through Shared Source Code

Detailed analysis of the data showed that the two teams reacted differently to project deadlines; the level of activity in the collocated team was more controlled before the feature freeze date, but increased afterwards. The collocated team was found to have a higher degree of collaboration with respect to specific code elements; while the distributed team kept the code they modified separate from each other.

The weekly averages for code changes for different time periods of the project were calculated to provide a picture of how each team reacted to different parts of the project. Both teams handled the steady state before a deadline in the same manner. However, before a deadline, the collocated team was able to handle the collaboration in a steadier manner – the interviews with the collocated team speculated that this was due to questions being resolved face to face with individual developers consulting others before submitting a code modification.

Multiple team members on the distributed team cited the fact that they had drawn clear lines between code elements and make an explicit attempt to only modify certain elements of the code. In contrast, when the collocated team assigned particular functional areas of the product to different developers, they often reassigned particular SPRs based on workload and felt comfortable with any developer modifying any part of the product. While the data suggested greater technical collaboration on the collocated team, there were code elements on the distributed team that involved more than one developer. Thus, even when distributed, the software developers did reach out to others for help when certain threshold barriers for requiring higher levels of collaboration were reached.

Nature of Team Meetings

The team meetings held by the distributed team were found to be more tactical and task oriented than the collocated teams, further demonstrating that each team had adapted similar processes in different ways to their own geographic structure. The two team's meeting minutes were controlled by many factors that allowed data collection to proceed with confidence. All meetings on both teams were held by the same project manager, who kept detailed minutes of each meeting in the same format. The categories for the agenda changed over the year to fit the stage of the project schedule, but were generally found to be consistent between the teams.

The distributed team devoted a larger number of items in the meeting minutes to tactical issues. Items were designated as tactical if they were short term in nature and all knowledge related to completion of the item was already acquired. The meeting minutes were analyzed by inspection, and all items in the meeting minutes were designated as strategic or tactical; no other categories were used. Examples of tactical items found in both teams' meetings included issues related to the "build" (a compilation of source code into an intermediate internal product release to be sent for testing), issues related to a particular SPR, or issues related to scheduling. Examples of strategic items found in both teams' meetings included discussion of feature plans for the next release, discussion of major customer issues, and discussion of cross-team collaboration with other teams in the company. The collocated team found ways of handling the tactical issues outside of the formal meeting structure, because opportunities for synchronous communication were available.

Using Technology to Update Work Item Status

Data from the Software Problem Report database were useful in demonstrating how technology was used to update work item status. SPRs represent the core work items for these software development teams, outside of feature level work. When any work is required on the source code – either a bug found by the testing team, an enhancement requested by a customer, or a feature – an SPR is logged and is used to track the status of the work. Each team was found to use the SPR system in a unique manner. While e-mail data described the social network on both teams and source control data described the technical network on both teams, these SPR data acted as a bridge between the social and technical networks.

Both teams shipped a final product release in the first quarter of the year, and thus this high period of activity in the early part of the year represents the SPR "clean-up" activity which occurred for the distributed team as they were updating status on all of the work which had been done for the release. The outliers in the data highlighted that the collocated team required a major focused one-time cleanup immediately preceding the product release, and immediately preceding the feature freeze date.

When team members were not available to consult with immediately, they added updates to SPRs in the context of the particular issue and wait for a reply in the form of another action taken on the SPR. With the collocated team, since answers were available immediately, it was not useful for them to take the time to update the formal SPR system when sharing knowledge around a particular SPR.

This demonstration of adapting available technologies in different ways has positive and negative points. The positive aspects are that the team has naturally innovated and found new uses for an existing infrastructure. However with this innovative use comes the caveat for managers that tracking results on a system such as the SPR system will not yield similar reports for teams which use the system differently. The collocated team had more individuals modifying particular elements of the source control system while the distributed team had more individuals modifying particular elements of the SPR system. This suggests that there are certain thresholds for collaboration and different geographic structures can lead to different levels of social and technical collaboration.

24-HOUR KNOWLEDGE FACTORY: IMPACT ASSESSMENT

The variance in the data between the two teams encourages discussion of the impacts of geographic distribution of knowledge-based teams at various levels – individual, team, organizational, institutional and national.

Individuals: Individuals who work in a knowledge based industry have the power to make choices about the global working environment. They possess the potential to use software tools similar to those used in this study to educate themselves on the work of their own teams and to become more capable in terms of the ability to work in a distributed work environment. Individuals in such environments may need to alter their work hours to spend a few minutes in their off-hours to use the telephone or instant messaging to communicate with colleagues working in a different time zone. A change in work styles may require more effort to be placed in explicit informal communication

on a distributed team, or in more formal documentation of informal decisions on a collocated team.

Teams: At the team level, an understanding of the socio-technical forces which impact knowledge sharing on a software team can impact the success of both the project and the product. Software tools that continually collect and display information can be useful in attaining optimal productivity in a decentralized environments. Building and implementing such tools would provide access to data which resides in distributed and heterogeneous sources and is not currently used by managers to guide decisions. One example of the utility of such a "dash board" is in assessing the technical dependencies between members of a team by looking at the SPR and source control data.

Organizations: At the organizational level, the data collected in this study demonstrates the potential for organizations to assess the tacit knowledge capital that is not readily quantifiable. Organizations currently assess knowledge capital by counting the number of patents filed or tabulating features on existing products; with new data capture tools, organizations can assess knowledge capital at a much more granular level. One can now assess the dependency on one development site or another, and on one developer or another. This is especially important in a domain such as software engineering where knowledge flows so dynamically between geographic locations.

Institutions: A number of institutions are impacted by the introduction of granular knowledge sharing data analysis in globally dispersed teams. The laws and regulations that govern labor and trade are not yet built to handle redefinitions in work requirements and intellectual property sharing which occur instantly and cross geographic borders. Unions and professional associations which represent one region of technical knowledge workers can act as both enabling and threatened institutions. They can enable the success of global software teams by training their members to build the capabilities necessary to operate in a geographically distributed environment, and also by expanding their regional scope so that their incentives are aligned with those of the multi-national firms which employ them. However they can also act as a threatened institution by deciding that the

work models, regional job opportunities and technical expertise requirements will be negatively impacted by the distribution of work. In all of these cases, the notion that knowledge sharing can be analyzed and leveraged is important in assuring that institutions impacted are able to adapt appropriately to the changing realities of the workplace.

Nations: New national policies need to be developed for training and preparing workers for globally distributed work, and also for dealing with issues related to sharing of intellectual property. In the case of the 24-Hour Knowledge Factory, intellectual property will be imported, leveraged, and exported on a daily basis. As public policy evolves to value and regulate exports at this level of granularity, the ability of nations to exploit wage differences would be significantly limited. This reinforces our pivotal theme that future offshoring endeavors will be fueled, not by considerations of cost savings, but by strategic considerations.

CONCLUSION

From an analytic viewpoint, the authors believe that significant opportunity exists for developing theoretical and analytical models for offshoring practices. By rising above the emotive arguments based on anecdotal evidences that currently tend to dominate debates and discussions on IS outsourcing, we can take a more comprehensive view of the situation. So far, analytical models focusing on offshoring practices have been few in number. A new generation of comprehensive analytical model needs to be created to investigate the emergent phenomenon of offshoring at a global scale.

From a business viewpoint, the concept of offshoring was originally fueled primarily by considerations of reduction of labor costs. Companies continue to proceed with plans to outsource with the benefits accruing primarily to their shareholders and their customers; however, government agencies have adopted diverse practices primarily because of concern for feelings of the voting population. Based on a variety of reasons, decisions made by companies on the issue of outsourcing of professional services will increasingly be driven by strategic considerations than by considerations of cost savings. This

hypothesis has been validated in this paper using a mathematical model. In practical terms, the need to bring new products and services earlier to the market may outweigh the considerations of cost and where the work will be performed. Over time, workers will be retrained and will acquire new jobs that are more suitable for their respective background and location, both in developed and developing countries. One now has the opportunity to move towards the “24-hour global knowledge factory” where outsourcing means active engagement on knowledge intensive tasks for 24 hours a day. Already, an increasing number of companies are using the notion of two geographically work centers to improve the pace and the quality of the work; these serve as harbingers of paradigms involving three work centers configured as a 24-Hour Knowledge Factory. A detailed case study was conducted at IBM to study the relative performance of distributed and co-located work teams. The results of the case study reinforce the main points raised in this paper. As firms, governments, and individual workers gradually embrace the growing realities of the marketplace, offshoring could become a “win-win” situation for all, leading to the globalized world of 24-hour knowledge factories.

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