High-Value Outsourcing:

Impact of Team Structure and Capabilities on Complex and Uncertain Offshoring Projects

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Abstract

Extant research on offshore outsourcing has largely studied non-core, fairly routinized tasks, such as IT services and BPO. However, companies have recently begun outsourcing higher-end work entailing greater complexity and uncertainty, including knowledge-based services like new product development. We hence investigate to what extent the offshore outsourcing approach can effectively transfer to such projects, by developing a simulation model based on field research of a sample of global software development projects conducted by a leading Indian outsourcing vendor with its customers. We contrast the *global delivery model* with a so-called *consulting model* and find that an offshore outsourcing approach based on distinct strategic complementarities can handle sophisticated higher-end work, by adopting a suitable team structure and capability composition. The results bear implications for traditional notions of firm boundaries and organizational forms.

Extant research on offshore outsourcing has largely focused on non-core, fairly routinized, and easily codified tasks conducted by external vendors for client firms, such as IT services, infrastructure maintenance, and business process outsourcing of support functions (Aron & Singh, 2005; Ethiraj et al., 2005; Huckman, Staats, & Upton, 2008; Rothaermel, Hitt, & Jobe, 2006). However, in recent years, companies have begun using the offshore outsourcing model for more sophisticated higher-end work, such as R&D and other knowledge-based services (Andersson & Pedersen, 2010; Contractor et al., 2010; Levina & Vaast, 2008; Engardio et al., 2005; Quinn, 1999, 2000). Unlike traditional IT and business process offshoring, high-value activities such as new product development of hardware and software are characterized by substantial complexity and uncertainty (Allen & Hauptman, 1987; Burns & Stalker, 1961; Iansiti, 1998; Tabrizi, 1994). Examples of such work include semiconductor design, telematics products, consumer electronics devices, and mobile phone software, to name a few.

Intuitively, as well as on the basis of a well-established body of empirical evidence, we expect the need for ongoing and active coordination to be significant in these types of projects, along with the application of specialized knowledge (Cohen & Levinthal 1990; Eisenhardt & Tabrizi 1995, Iansiti 1995, MacCormack et al. 2001, Tabrizi 1994; Li, 2008; Srikanth & Puranam, 2007; Tiwana & Keil, 2007; Xu, Yates, & Orlikowski, 2005; Hendry 1995; Reitzig & Wagner 2010; Weigelt 2009). Extant literature in outsourcing, new product development, innovation and organizational theory suggest that projects characterized by these features require organizational arrangements fostering small vendor team sizes, co-location with the client, as well as high levels of domain knowledge (Hinds & Kiesler, 2002; Stewart, 2006; Cohen & Levinthal 1990; Iansiti, 1998). However, such a step is in contradiction to the offshore outsourcing approaches that are propagated and utilized by the service providers today (Ethiraj et al., 2005; Huckman, Staats, & Upton, 2008; Levina & Vaast, 2008; Srikanth & Puranam, 2007).

It is therefore an open question whether distributed work practices as embodied in the so-called global delivery model, which lies at the heart of the IT and back office outsourcing boom, transfers effectively to the offshoring of product development and related high value-added activities. We hence study the design and execution of such projects, seeking to answer the following questions: What is the impact of the task conditions, organizational structure, and team capabilities on project performance? What are the implications for firm boundaries and organizational forms?

To address these queries, we develop a simulation model based on field research of a sample of global software development projects conducted by a leading Indian outsourcing vendor with its customers, entailing primary collection of a unique data set. We contrast the small size, high onsite presence, high specialization of knowledge team organization (the *consulting model*) with the high offshore presence, large generalist dominated outsourcing approach (the *global delivery model*). We find that an offshore outsourcing approach based on distinct strategic complementarities is able to handle sophisticated higher-end work – in other words, the global delivery model can be extended to high complexity and high uncertainty projects with suitable organization. In the subsequent sections of this paper, we provide an overview of the theoretical framework, methods, model of such offshore outsourcing projects, simulation results, derived propositions, and implications of the findings.

Theoretical Framework

Drawing upon the literatures on offshore outsourcing, innovation management and team design, we identify a set of basic constructs that affect the behavior and performance of offshore outsourced new product development projects: the underlying task conditions and the selected organizational structure of the team. Extant research on new product development suggests that in such projects, the underlying task conditions can be characterized in terms of complexity and uncertainty (Allen & Hauptman, 1987; Burns & Stalker, 1961; Iansiti, 1998; Tabrizi, 1994). Complexity stems from the interdependence among tasks and domains, existing at product and organizational levels (Iansiti 1988). Uncertainty, meanwhile, arises from unpredictability of the evolution of scientific advances, customer needs, and competitive environments, which manifest themselves at product and environment levels (Iansiti, 1995, 1998;

MacMillan & McGrath, 2002; MacCormack & Verganti, 2003). Resolving the complexity and uncertainty to move forward the product development to its desired end-state requires the exchange of domain-specific knowledge as well as considerable coordination to solve technical problems and respond to emerging needs (Eisenhardt & Tabrizi, 1995; Iansiti, 1995; MacCormack et al, 2001; Tabrizi, 2004).

A fundamental organizational lever influencing the ability to do so is the chosen configuration of the vendor team. Three salient dimensions identified by past scholarship on team design as well as recent studies on offshore outsourcing that can affect the scope and nature of knowledge worked upon, coordination and ultimately project performance, are the size of the team, extent of co-location with the client (onsite-offshore distribution of employees) and level of domain knowledge (Hinds & Kiesler, 2002; Stewart, 2006; Ethiraj et al, 2005; Huckman, Staats, & Upton, 2008; Levina & Vaast, 2008; Srikanth & Puranam, 2007; Xu, Yates, & Orlikowski, 2005). While the literature has often examined individual variables in isolation, we take a collective view of the team structure as there may be an inter-play between them.

The basic managerial imperative in outsourced product development projects is to solve the substantial coordination problems that arise from the complexity and uncertainty and apply the specialized knowledge to accelerate and improve the solution development, while benefiting from the distributive work practices of the global delivery model, which exploits cost advantages (especially in labor) by offshoring as much work as possible to cheaper or more efficient locations (Srikanth & Puranam, 2007; Tiwana & Keil, 2007; Willcocks et al. 2004; Xu, Yates, & Orlikowski, 2005). The fundamental trade-off hence becomes whether to send a small group of expert employees onsite for better coordination and knowledge manipulation between the vendor and the client to quickly and effectively address the product development challenges, or to keep them offshore to contain the project costs and thereby allow for a larger team overall with the minimum concentration of specialists that is required.

We label the first type of team organization, whose effectiveness is supported by the findings in the existing literature, the *consulting model*, patterned after the typical arrangement of management consulting teams. This approach rests on the assumption that innovation-related work requires considerable levels of exploration relative to exploitation, with the need for generation of new knowledge being extensive (Levinthal, 1997; Levinthal & March, 1993; March, 1991). Under such circumstances, smaller teams would be more productive (Hoegl, 2005; Latane, Willaiams & Harkins, 1979; Mueller, 2012; Thomas & Fink, 1963), greater co-location of the vendor with the client on their site would allow for better tacit knowledge transfer (Haas & Hansen, 2007; Hinds & Kiesler, 2002) and high levels of specialized domain knowledge that help to bridge technological solutions with application contexts should prove more valuable (Cohen & Levinthal, 1990; Iansiti, 1998). Applying this logic to the outsourcing context, sending small teams comprising individual experts with substantial domain knowledge onsite to the client would improve the performance of the new product development projects entailing complexity and uncertainty which are conducted by a vendor.

We argue however, that the alternate model, the offshoring-based *global delivery model*, could be at least equally effective for such work. This type of approach, having large teams offshore with the minimum needed specialized knowledge, is predicated upon the notion that exploitation is as important if not more so than exploration, since novelty often arises from the recombination of existing knowledge components as opposed to the generation of new ones (Fleming, 2001). If this is the case, then it would be sufficient to have a limited number of experts to interact with the client and generate the key ideas, with a large staff of engineers who can sit offshore (and incur a lower level of cost) to execute the various combinations of knowledge components (Singh & Fleming, 2010).

In fact, too high a concentration of domain knowledge could also have adverse consequences, besides not being necessary (Haas & Hansen, 2005). For instance, it could induce a “prima donna effect” – a clash of egos among highly knowledgeable star performers who have strong individual views on the appropriate solution, thereby negatively impacting the team dynamics and ultimately outweighing the benefits of their collective wisdom (Dickerson, 2001). While large teams may on average be less productive, at a lower (offshore) cost base, their effective output per dollar of employee salary could surpass onsite teams. In addition, twenty-first century collaboration technology which can allow means of richer communication and standardization of processes (e.g. through common information technology tools for conducting work and interacting) as well as task modularity, can alleviate the need for face-to-face interaction (Hinds & Kiesler, 2002). Moreover, while partial co-location may be beneficial to coordinate with clients, it may not be necessary to do so in large numbers, which bear greater costs and may even impact the intra-team coordination of the vendor team. In summary, several factors suggest that the global delivery model, can be as effective as the often advocated consulting model even when the work that is conducted by a vendor for a client is based on knowledge and entails complexity and uncertainty, beyond the typically non-core routinized, easily codified, tasks commonly successfully outsourced today.

Methods

To test the two organizational approaches, we develop a simulation model based on field research, drawing on data on more than 200 offshore outsourced software product development projects executed by a leading Indian provider. The sample encompassed a wide range of industries, clients, project sizes, requirements, team compositions, and contracts. We collected detailed data about operational processes from two sources to cross-validate their accuracy: company databases as well as interviews with executives.

The choice of a simulation approach stems from our desire to investigate the interactive effects of team structure and capabilities and the project dynamics and outcomes, necessitated by the interdependencies amongst the salient constructs (Aggarwal, Siggelkow & Singh, 20111). In order to represent the actual processes prevalent in high-value outsourcing, which happen to be mutually dependent, we created a stock-and-flow model structure based on the principles of system dynamics since this is an accepted method for investigating complex endogenous dynamics. In doing so, we used interview insights to understand the constructs and mechanisms, while utilizing the data to determine parameter values and relationships between variables. After validating the simulated outputs from the model, we ran carefully designed experiments to understand interdependencies and dynamics arising from varying important parameters.

Overview of the Model

The outsourcing process can be characterized as a race to create a software product that meets the time and quality constraints of the customer while minimizing cost. There are three important aspects that arise from the process: the nature and content of the produced software such that it closely represents the actual needs of the client, the ability of the developer to produce and commence operating the software within the agreed time-frame, and the cost incurred by the developer (vendor). These are achieved through two kinds of operational tasks: 1) resolution of ambiguous issues (through coordination) that have the potential to create misunderstandings about the process being outsourced given the underlying complexity; such resolution helps all concerned to understand and define problems so as to facilitate accurate coding and 2) writing and testing the code that constitutes the software product, subject to the quality and time constraints imposed by the client.

In addition, vendor management seeks to minimize project cost by manipulating the productivity of the two operational tasks. At the planning and at the operational level this is pursued by controlling the size of the team allotted to the project, and the constitution of the team in terms of off-shore and on-shore personnel, respectively. However, there are other decisions to be made from a long-term strategic capability point of view, regarding the productivity and knowledge levels of personnel who constitute the team which executes the project. An overview of how these tasks interact with each other is shown in Figure 1.

The two aspects of the task of writing the code are separated out: the creation of software code by programmers and the reduction / removal of the defects that are generated during the process of creating the code. Resource allocations, in terms of quality and quantity of manpower, determine the speed and the quality at which the three operations are performed. Since all the different tasks are carried out in parallel by all team-members, the characteristics of the resources allocated determine the balance between the different operations as well as the trade-off between the time taken and the costs incurred. The actual progress made in the different operations may influence further resource allocations, indicating interdependency among task completion and resource allocation. We now look at each portion in detail to represent the nature of the tasks and the processes that drive the completion of these tasks.

Resolution of Ambiguous Issues through Coordination

Processes within organizations are constituted of sequences of actions which may be pre-defined or path-dependent. The knowledge that determines the sequence of actions may not have been codified or documented to the fullest extent. Consequently, the vendor, who may not have had the opportunity to participate in such processes, would find it difficult to reproduce the appropriate sequence of actions and the associated logic. Hence, at the beginning of the software creation process, there would be a stock of ambiguous, unresolved issues. The nature and quantity of such issues depend on certain complexity-related project characteristics such as its size, degree of tacitness and non-modularity. Such issues need to be clarified, understood and resolved by the vendor team in order to facilitate accurate process reproduction. Both offshore and onsite personnel participate in this activity; the faster such issues are clarified and resolved, the quicker can software creation be brought to a close.

The rate at which such clarification is carried out depends on the characteristics of the circumstances such as (a) the richness of tools applied, (b) the uncertainty regarding the precise degree to which processes and existing knowledge need to be reproduced which is dependent on the associated innovation, (c) the relationship between the client and the vendor, (d) the characteristics of the human resources dedicated by the vendor (quantity of on-shore and offshore personnel, domain knowledge of the personnel, etc.) as well as the share of such issues already resolved. The productivity of on-shore personnel is resolving such issues is higher than the productivity of off-shore personnel as the communication of on-shore personnel is subject to lesser constraints.

Code Generation

The effort towards the amount of code written depends on the composite productivity of the team. This is a function of the productivities of the on-shore and off-shore personnel as well the *a*ctual number of such team members. However, the productivity is not simply a weighted sum of the produce of the two kinds of personnel since we account for the degree of effective cooperation among personnel. The degree of effective cooperation is a decreasing function of the total manpower available for the project – i.e. larger the total team size, the greater is the impediment on the output of the team. This also accounts for the hierarchical control that needs to coordinate the work produced by large teams. The effort in generating the code accumulates towards the finished product that would be ultimately delivered for use by the client. Note that all code that is written is not automatically accepted as part of the finished product; the degree to which the above-mentioned ambiguous issues have been resolved is a key determinant of the code that is counted as acceptable work.

The amount of acceptable work determines the amount of code yet to be written. In turn, this influences the changes made to the size of the team, based on the danger of falling behind the time limit set for the project. Thus there is interdependency between the amount of work accomplished and the nature of manpower available to do the work. Of course, increasing the team size to complete the work on time increases the cost incurred by the developer.

Defects in the Created Code

Defects and flaws are inherent in any code created by team members. The presence of defects does not reproduce the outcomes desired from the series of actions performed by the software; hence these defects need to be eliminated and their effects made insignificant. Initially, the defect level (i.e. the rate at which defects are generated for every line of code written) is much higher than what is feasible for the client. It needs to be reduced to an acceptable level. This consumes resources and time. Even as the defect level is being reduced, the accumulated number of defects in the written code keeps on increasing. After reducing the defect level, the total number of defects already incorporated in the written code needs to be reduced below the tolerance limit specified. On certain occasions, the team may finish creating the code, but the number of defects in the product may not be down to the tolerable limit; hence, additional resources need to be consumed in order to bring down the number of defects.

The rate of reduction of the level of defect depends upon the productivity of the off-shore personnel of the team and also on the ratio of the on-shore personnel to the off-shore personnel. Typically, such reduction is pursued till the level is some way below the expected level of defect; this level declines with the fraction of work completed. If and when the total number of accumulated defects exceeds the expected value, reduction of the defect level is pursued again. The number of defects that accumulate in a given period of time is the product of the average defect level over that period in time and the number of lines of code written over that period. The number of defects accumulated influences the changes made to the composition of the team, if there is a danger of falling behind the quality specifications set for the project. Thus there is interdependency between the number of defects accumulated and the nature of manpower available. Of course, increasing the on-shore proportion of the team to reduce defects increases the cost incurred by the developer.

Manpower Quantity and Quality

The size of the team and its composition in terms of the proportion of on-shore personnel affect all the major tasks – code generation, defect removal and resolution of ambiguous issues. As seen before, there is interdependency among these parameters and the speed at which acceptable work is completed. An increase in the ratio of on-shore personnel may be triggered by any of the three following conditions: a) if the actual number of defects is not within expected limits at predetermined action points in time, b) if the excess number of defects persists despite action taken under the previous condition and c) schedule pressure triggered by a concern that the effort towards finishing the work on time is inadequate. Of course, the last condition may be addressed also by increasing the team size rather than increasing the ratio of on-shore personnel. While the productivity of on-shore personnel is higher than that of off-shore personnel, the cost ratio for on-shore to off-shore personnel is even higher; hence management needs to be aware of the marginal costs and benefits of using on-shore vs. off-shore personnel.

Simulation Experiments and Results

We simulate the model to understand the behavior of the system by carrying out various experiments which examine the (cost performance) impact of different organizational strategies in terms of team structure and capabilities on project performance under different task conditions. These experiments explore how trade-offs at different levels of planning affect it. These levels are: a) planning for a particular project where a steady team size and an initial ratio needs to be chosen; b) execution of a project where a choice between on-shore and off-shore expansion needs to be made and c) developing strategic capabilities for future projects which involve decisions about cultivating domain knowledge and developing productivity for on-shore and off-shore personnel.

Project Planning Trade-offs

In the first series of experiments we explore the impact of choosing different initial on-shore ratios for a given team size. As work on the project advances, it might become necessary to increase the proportion of on-shore personnel so as to meet quality and time constraints. While starting with a low initial on-shore ratio has cost advantages, such choices fall short of being able to finish by the desired time. On the other hand, starting with a high initial on-shore ratio incurs greater cost. In our experiment, we explore the entire range of on-shore proportions from 0 to 1, for a fairly wide range of team sizes.

The results are seen in Figure 2; each curve represents a particular initial value of on-shore proportion. It shows that while higher initial ratios lead to monotonously increasing costs irrespective of team size, lower initial values of ratio show U-shaped curves that register a minimum at moderate values of team size. The implication is that at low team sizes, lower initial ratios are not enough to finish the project on time and hence need additional manpower which increases cost. In turn this suggests that the optimal team-size at the planning stage would be a low-to-medium value, rather than low or high values.

This is confirmed in Figure 3 which shows that very low team sizes are indifferent to the initial ratio but that the cost is appreciably lower for team sizes of low-to-medium values. The lowest value occurs not at very low values of ratio, but in the range of 0.15 to 0.35.

PROPOSITION 1a. Increasing initial on-shore proportion increases the total cost for the range of on-shore values that can be employed realistically.

PROPOSITION 1b. Increasing team size increases the overall cost for higher values of initial on-shore ratio while there is a U-shaped cost curve for lower values of initial on-shore ratio.

PROPOSITION 1c. The rate at which cost changes with respect to initial on-shore ratio is positive and increases with high team size. For low team sizes, this rate is negative when the initial value of on-shore ratio is less than 0.4 but at higher initial values of on-shore ratio, it changes from negative to positive with increasing team size.

Project Execution Trade-offs

In the second series of experiments we explore the impact of choosing different ways to increase team size. Once the project has started, there is always a possibility that more labor is needed since the original team members may have left, or the team has fallen behind schedule and then needs more personnel to get back on schedule. Thus the two strategies are: 1) either increase onshore personnel or 2) increase off-shore personnel. Figures 4 and 5 show the results of these experiments. Initial on-share proportion varies from 0 to 1 in Figure 4; the corresponding initial team size varies from 0.7 to 1.4. The results show that for low initial values of on-shore ratio the strategy of adding off-shore personnel is less costly while for higher initial ratios of on-shore personnel, it is more cost-effective to add on-shore personnel. The cross-over in strategies occurs around the initial ratio of on-shore personnel being 0.45 which corresponds to an initial team size of about 0.95.

PROPOSITION 2a. The rate at which cost changes with respect to initial on-shore ratio is positive when the strategy of adding off-shore personnel is followed. It is negative when the strategy of adding on-shore personnel is followed.

PROPOSITION 2b. The rate at which cost changes with respect to initial team size is negative when the strategy of adding off-shore personnel is followed. It is positive when the strategy of adding on-shore personnel is followed.

Developing Strategic Capabilities

In the third series of experiments, we return to the model of the first experiment. However, instead of varying team size and initial value of on-shore ratio, we now explore the impact of varying Domain Knowledge Index from its base value of 1 to 2.5. This variation is carried out for four different configurations: a) low initial on-shore ratio (R=0.2) and low team size (TS=1.1) b) low initial on-shore ratio and high team size (TS=2.7) c) high initial on-shore ratio (R=0.8) and low team size and d) high initial on-shore ratio and high team size. There are two observations to be made from Figure 6.

First, cost is a U-shaped function with increasing domain knowledge index which leads to the implication that investing to increase domain knowledge beyond a certain value is counterproductive. The structure of the model reveals that an increase in domain knowledge increases the pooled domain knowledge, which is also aided by the prior relationship between the vendor and the client. However, increased domain knowledge has a negative effect on the productivity to resolve ambiguities since increased domain knowledge on part of the vendor may lead to an increased need for clarifications, increased disputes etc. arising from differing points of view on how to reproduce existing client processes.

PROPOSITION 3. The relationship between cost and domain knowledge index is U-shaped.

Second, while there is a drop in cost when one moves from the first configuration 'a' to the second configuration 'b' (net increase in team size only), there is an increase in cost when one moves from the third configuration 'c' to the fourth configuration 'd' (net increase in team size only). This reflects the interdependency between team size and initial on-shore ratio.

Contributions, Discussion, and Future Directions

In this paper, we have investigated the impact of the task conditions, organizational structure, and team capabilities on the performance of offshore outsourcing projects facing complexity and uncertainty. We have shown that team structure, including size and composition, has a significant effect on cost. While the isolated effects of size and composition are as expected, we also demonstrate that interdependence between the two determines the optimal strategy that management needs to follow. In addition, we have shown that persevering with off-shore personnel after starting with a low initial ratio of on-shore personnel is a competitive strategy. Finally, we have also demonstrated the limits to investing in capabilities of individual team members.

Our results, supported by the optimal structure of low on-shore ratio with low to medium team size, imply that a global delivery model (based on limited on-shore presence) is transferable to more sophisticated and high-value tasks that entail greater complexity and uncertainty. The distinctiveness of the global delivery model is reinforced by the limits to investing in individual capabilities, indicating the importance of enhancing strategic complementarity through the development of group-based capabilities. These implications propose an alternative organizational structure to the globally disaggregated and distributed structure currently seen in many MNCs.

One area of further work is to examine the effectiveness under varying task conditions, and to test the limits of the global delivery model. It is conceivable that one model performance is superior under one set of tasks, while the other excels in another (e.g. complexity vs. uncertainty). It is also possible that the global delivery model reaches a limit after which the consulting model is indispensible. Additionally, the nature of the work in the project can be conceptualized from a product point of view, and more from the type of knowledge which needs to be brought to bear along with the method of application; for instance, client-specific vs. domain-specific know-how, or a self-contained modularized component or system as opposed to true joint work with the client. This line of thinking is motivated by the prevalent model in the advertising and the product design industries where the work is highly creative – yet the agency teams do not feel the need to be continually present onsite at the client. These aspects are the subject of a further inquiry that we are pursuing.

To the best of our knowledge, this is the first simulation of offshore outsourcing processes, providing an examination of interdependencies and tradeoffs in outsourcing projects, including linkages between task, organization, and performance, with insights for theory as well as practice. While our field-based simulation modeling approach benefits from the combination of depth and rigor, we also suffer from the limitations stemming from simplifying assumptions having to be made, as common in any simulation. Nonetheless, we believe such work is valuable to illuminate the rising and important phenomenon of high-value added offshoring outsourcing, which has implications for our understanding of firm boundaries and organizational forms.

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Figures

Figure 1 - Overview Diagram

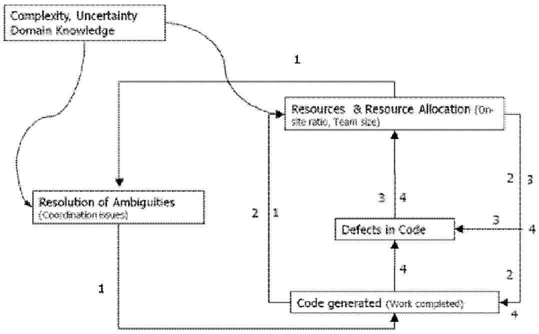

Figure 2 – Experiment 1 (fixed team size and initial on-shore ratio)

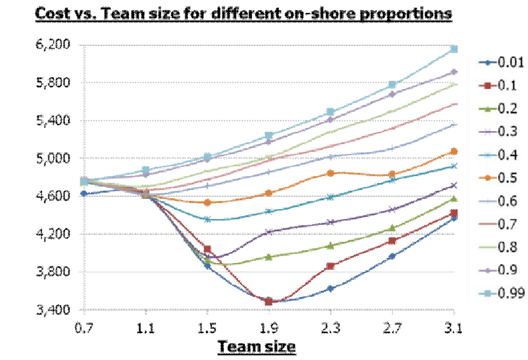

Figure 3 – Experiment 1 (fixed team size and initial on-shore ratio)

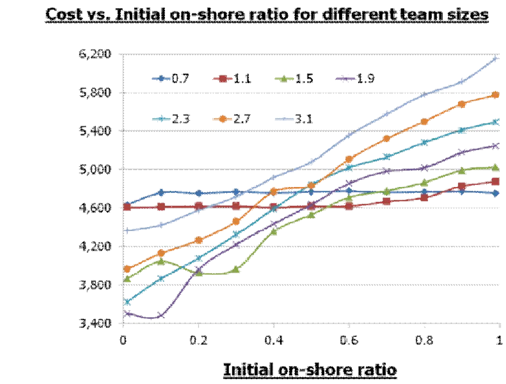

Figure 4 – Experiment 2 (fixed initial team size and related on-shore ratio)

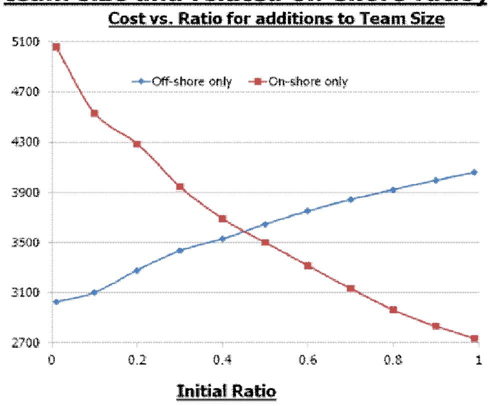

Figure 5 – Experiment 2 (fixed initial team size and related on-shore ratio)

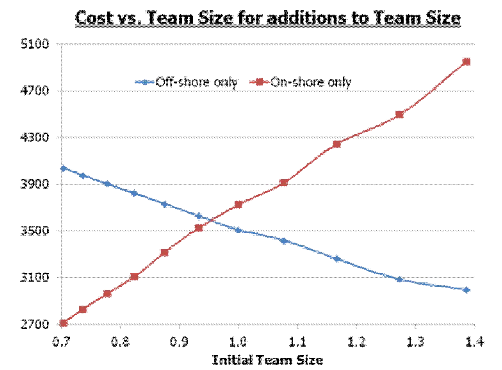

Figure 6 – Experiment 3 (fixed configurations of size and initial ratio)