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Managing Issues through the Lifecycle of IT Service Offshoring Projects

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Abstract--**Western countries' information technology and software intensive firms are increasingly producing software and IT services in developing countries. With this swift advancement in offshoring, there are many issues that can be investigated to enable companies to maximize their benefit from offshoring. However, significant challenges can happen throughout the lifecycle of offshoring IT service projects which turn the potential benefits into losses. This research investigated CMM/CMMI best practices and their effect on managing and mitigating critical issues associated with offshore development.**

I. INTRODUCTION

Information Technology (IT) service offshoring describes the transfer of IT services to an offshore supplier in a near or far away country. The services themselves are partially or totally transferred [1-7]. IT offshoring is worth being researched because it has specific characteristics that distinguish it from the well-researched field of IT outsourcing. IT services and software development offshore is becoming a dominant paradigm in the IT services and software development industry [8, 9].

Western countries' information technology and software intensive firms are attracted to offshoring in developing countries because of the promised benefits of: lower costs, faster delivery speed, the ability to focus their in-house IT staff on more higher value work, access to supplier resources, capabilities and process improvement [10]. Not all IT service and software development projects benefit from offshoring as half of the organizations that shifted processes offshore failed to realize the benefits they expected [5, 11-13]. The literature indicates that 20% of offshore software development contracts are cancelled in the first year, more than 25% of all offshore software development projects are cancelled outright before completion and 80% of offshore IT projects overrun their budgets [14].

A growing number of organizations are adopting the Software Engineering Institutes' (SEI) The CMM/CMMI models to improve their IT service and software development process. CMM/CMMI models were originally developed as methods for the objective evaluation of contractors in military software projects (domestic outsourcing) [15-17]. The CMM/CMMI models are internationally adapted and have received great publicity in the software development industry [18]. CMM/CMMI models became an industry standard based on industry best practices and features an industry standard appraisal methods [19, 20].

The literature reveals that CMM/CMMI have been well researched and are proven to mitigate the issues and challenges of *outsourcing* IT services and software development projects [21-37]. However, there is limited research and investigation of CMM/CMMI best practices and how they mitigate the issues and challenges of *offshoring* of IT services and software development projects [38-43]. Therefore, this study examined the relationship between CMM/CMMI software process development and (1) the issues and challenges of offshoring IT services projects and (2) offshore IT services project performance outcomes.

II. LITERATURE REVIEW

The globalization of resources resulted in the dramatic increase in offshoring. Although client companies have offshored manufacturing services for decades, the practice of offshoring IT services is still maturing.

Academics have been studying domestic IT outsourcing since the early 1990s. The first published outputs from academic research appeared in 1991 and documented companies pursuing large-scale domestic IT outsourcing [44, 45]. However, the global software industry has experienced exponential growth beginning in the mid1990s [46-48].

In the area of IT offshoring, academics are trying to understand how offshoring differs from domestic outsourcing. So far, researchers have found that offshoring poses additional challenges compared with domestic outsourcing [49]. For example, offshoring is more challenging because of: time zone differences [50], the need for more control [51, 52], cultural differences [53, 54], defining requirements more rigorously [51, 55], the difficulties in managing dispersed teams [56], and politically driven interests between the client and the service provider [57]. Researchers are also looking at offshoring at both the decision and relationship levels [58].

Applying the CMMI model forces companies to commit to a number of instrumental procedures and assessments. Getting the CMMI accreditation is a great advantage for both the clients and the employees of an organization. It improves the quality of the products and services as well as improving the productivity of the companies by enhancing work procedures. Getting the CMMI accreditation also promotes and reinforces the company's capabilities to predict a project's schedule, achieve a higher return on investment and enhance the capability to manage challenges and issues associated with the outsourcing of IT services.

A. Research Objectives and Questions

Critical issues are the challenges that can happen throughout the lifecycle of offshoring IT service projects. This research investigated Software Engineering Institute' Capability Maturity Model (CMM) and Capability Maturity Model Integration (CMMI) best practices to manage and mitigate the offshoring issues throughout the lifecycle of IT service projects.

An online field survey was developed and tested in multiple ways: (1) via two expert panels (SEI expert panel and offshoring IT expert panel, (2) via a group of PhD students from the Engineering and Technology Management Department (ETM) at Portland State who have experience in offshoring and (3) by sending it to ten IT services companies.

This research will answer the following important questions:

Q1: What is the impact of client firms adopting industry standards on the frequency of issues experienced by client firms when offshoring IT service projects?

Q2: What is the relationship between the maturity level achieved and the frequency of issues experienced by client firms when offshoring IT service projects?

Q3: What is the relationship between industry standards practices and the frequency of issues experienced by client firms when offshoring IT service projects?

Q4: What is the impact of adopting industry standards on the offshored projects' success?

B. *Issues of IT Service offshoring*

In offshore relationships, users and business analysts usually reside at the client side and technical analysts and developers tend to perform their work from offshore locations [5]. Large geographic distances substantially accentuate the complexity of coordination in such global set-ups and demand strategies for working efficiently [59]. Some of the most common challenges faced in offshoring projects relate to: over-expenditure, hidden costs [60-63], communication problems, differences in project management practices, language barriers, time-zone differences, cultural differences, security and political issues and supplier site location [64, 65, 66-69].

Building on the work of Raffo *et al.* [72] and Setamanit *et al.* [70, 71] and other researchers [5, 38, 46, 53, 54, 73, 74] in the area of issues and challenges of offshoring IT service projects, the most common issues and challenges were identified and compared to other sourcing options as shown in Table 1 below.

As IT services and software development have high degrees of interaction between the client and the service provider with more dynamic requirements, communication problems, cultural differences, language and time zone differences create higher levels of challenges in offshoring compared with in-sourcing and outsourcing options [66, 83] as indicated in table 1.

Offshore subsidiaries are developed to overcome some of the problems with offshoring of IT services and software development to third party suppliers. Many firms have committed themselves to offshore in-sourcing strategy to obtain the advantages of low-cost professionals [84, 85]. In this model, foreign technology workers are employees of U.S. based companies and receive the same training, software tools and development process guidelines as their western counterparts [84]. The main difference between these workers and domestic employ is salary [84, 86].

TABLE 1: ISSUES/CHALLENGES LEVEL ASSOCIATED WITH EACH SOURCING OPTION

Issues/challenges	**Sourcing types**				
	In-sourcing		**Outsourcing**		**Offshoring**
	USA offices	**Offshore subsidiaries**	**National vendors**	**Multinational companies**	
Over expenditure/Hidden costs incurred by the client [75, 76]	Low	Low	Medium	High	*High*
Difference in interpretation of project requirements between the client and the supplier [38]	Limited	Low	Medium	Medium	*High*
Poorly developed and documented requirements by the client company	Limited	Low	Medium	Medium	*High*
Poor tracking and managing requirement changes by the client company [38]	Limited	Low	Medium	Medium	*High*
Lack of a full communication plan between the client and the supplier [70, 71, 9, 77]	Limited	Low	Medium	Medium	*High*
Communication and coordination problems between the client and the supplier [38, 78]	Limited	Low	High	High	*High*
Language barrier [64-66, 79]	Limited	Low	Medium	Medium	*High*
Time-zone differences between the client and the supplier [60, 64-66, 79, 80]	Limited	High	Low	Low	*High*
Cultural differences between the client and the supplier [63-66, 78, 80, 81]	Limited	Low	Medium	Medium	*High*
Incomplete and unclear contract [78]	N/A	N/A	Medium	Medium	*High*
Contract renegotiation and termination	N/A	N/A	Medium	Medium	*High*
Difference in project management practices between the client and the supplier	Limited	Low	Medium	Medium	*High*
Unable to measure performance of supplier	Limited	Low	Medium	Medium	*High*
Supplier technical/security & political issues [61, 63, 66, 78-80, 82]	Limited	Low	Low	Low	*High*
No previous experience of the supplier	N/A	N/A	Medium	Medium	*High*
Lack of supplier standardized working methods	N/A	N/A	Medium	Low	*High*
Poor execution plan- timing of transition to supplier [60, 65]	Limited	Low	Medium	Medium	*High*

Researchers have found that offshoring of IT services and software development work poses considerably more challenges than domestic outsourcing as in table 1. Offshoring is more challenging because of time zone differences [87, 88], the need for more controls [52, 89], distance and time-zone difference [56, 90], cultural differences [53, 84, 91-93], language problems [94-96], having to define requirements more rigorously [33, 55], difficulties in managing dispersed teams [56, 91], security and political issues [61, 63, 80] as shown in table 1. Therefore, critical issues of offshoring of IT services and software development are the focus of this research.

C. Project Success

Project success is the delivery of the agreed upon project scope, to the agreed quality measures and within the agreed upon timeframe and budget [97]. Reiss defined a project as "a human activity that achieves a clear objective against a time scale" [98]. Projects generally involve large, expensive, unique or high risk undertakings which have to be completed by a certain date, for a certain amount of money and within some expected level of performance [100].

As Erickson and Ranganathan [104] and Grover *et al.* [105] indicate, success can be understood and measured in multiple ways, including "the organization's satisfaction with the results of offshoring, an expectations fulfillment view [106], a cost/benefit approach [107] , a psychological contract perspective on fulfilled obligations [108] and a strategic fit view of success [104, 109].

A project is by definition an effort bound by "schedule", "budget" and "quality" [8, 104, 113] Thus, in this research these dimensional factors are utilized for measuring offshore project success.

D. Capability Maturity Models (CMM/CMMI)

The CMM/CMMI models are collections of best practices from leading engineering companies. They describe an evolutionary method for improving an organization from one that is ad hoc and immature to one that is disciplined and mature. The CMM/CMMI is internationally recognized and was developed by the Software Engineering Institute at Carnegie Mellon University.

The idea behind CMM/CMMI is that a high-quality process yields a high-quality product at the end. As a consequence, CMM/CMMI aims at providing objective measures for the quality of software development processes and strategies for their improvement. CMM/CMMI tries to define the key elements of an effective process and outlines how to improve suboptimal processes, i.e. the evolution from an "immature" process to a "mature, disciplined" one. It describes key practices for meeting goals for cost, schedule, functionality and product quality. CMM/CMMI ranks software developing organizations according to a hierarchy of five maturity levels, with the first being the least mature and the fifth being the most mature.

This research focused on the following CMM/CMMI models:

1) CMMI for Development/Services (CMMI-DEV, SVC)
2) CMMI for Acquisition (CMMI-ACQ)
3) CMM for People
4) CMM for Team Software Process (TSP)

E. Capability Maturity Practices

Fifty seven CMM/CMMI practices were identified to mitigate the IT offshoring seventeen issues. Table 2 presents an example of the CMM/CMMI best practices that are expected to mitigate the IT offshoring issue of over expenditure due to hidden costs incurred by the client company.

III. METHODOLOGY

Using a web-based survey, data was collected from Information Technology and software development firms across the United States. The survey population consisted of those who work on offshore IT and software development projects. The online survey was emailed to 9030 IT companies and received 558 surveys returned with a response rate of 6.14%. Quantitative methods were used to test the proposed hypotheses.

The Bonferroni correction was applied to control the Type I error rate, or the probability of rejecting a null hypothesis that is actually true.

TABLE 2: LIST OF IT OFFSHORING ISSUES AND CMM/CMMI BEST PRACTICES

Issues and challenges of offshoring	Industrial CMM/CMMI Best Practices
R1: Over expenditure due to hidden costs incurred by the client company	PR1: A project plan is established and maintained as the basis for managing the project. PR2: Establish and maintain the overall project plan. PR3: Estimate the project's effort and cost for work products and tasks based on estimation rationale. PR4: Establish and maintain the project's budget and schedule, milestones, constraints, dependencies. PR5: Monitor supplier project progress and performance (effort, and cost) as defined in the contract. PR6: Manage invoices submitted by the supplier.

IV. RESULTS AND DISCUSSIONS

A. Adopting CMM/CMMI models and IT offshoring issues

The analysis showed US IT companies that adopted CMMI-Development/Services and CMMI-Acquisition models reported fewer offshoring issues (80%). However, the investigation showed that these companies did not achieve good results with four IT offshoring issues under investigation of (1) Language barriers, (2) Time-zone differences, (3) Cultural differences and (4) Supplier security and political issues.

By contrast, the analysis showed companies that adopted TSP and People-CMM reported fewer issues with language barriers and cultural differences between the client company and the supplier company. This may suggest that there is a need to utilize and incorporate the different practices from TSP and People into CMMI for DEV/SVC and CMMI for ACQ to effectively and efficiently mitigate the issues and challenges of offshoring.

B. CMM/CMMI maturity level achieved and IT offshoring issues

The relationship between three CMM/CMMI maturity level achieved and the IT offshoring issues experienced by the client companies was tested: (1) Investigate the relationship between companies that achieved maturity levels 1 and 2 when applying CMMI for Development (DEV)/Services(SVC) and companies that achieved maturity levels of 3,4 and 5 with the 17 issues of offshoring IT projects; (2) Explore the relationship between companies that achieved maturity levels 1 & 2 when applying CMMI for Acquisition and companies that achieved maturity levels 3,4 and 5 and the 17 issues of offshoring IT projects; (2) Test the relationship between companies that achieved maturity levels 1 & 2 when applying People CMM and companies that achieved maturity levels 3, 4 and 5 and the 17 issues of offshoring IT projects.

Bonferroni's correction was used when multiple comparisons were drawn from a single sample. Hypothesis tests the 17 issues 4 times with 4 industrial standards. Bonferroni correction (adjusted) p-value= 0.05/(17*3) = 0.05/51 = P = 0.000980392.

The respondents indicated their maturity level achieved from maturity level 1 to maturity level 5. Table 3 lists the breakdown by CMM/CMMI maturity level for each CMM/CMMI model. The investigation found that IT companies that achieved higher maturity levels of CMM/CMMI reported fewer issues associated with IT offshoring.

For example, the analysis showed that (95%) of IT companies that achieved level 5 in CMMI-DEV reported (rarely or never) for the issue of difference in interpretation of project requirement issue when offshoring their IT projects. 90% of the IT companies in our sample that achieved level 4 in CMMI-DEV reported (rarely or never) for difference in interpretation of project requirement issue when offshoring their IT projects. On the other hand, only 8% of the companies achieved level 1 in CMMI-DEV reported (rarely or never) for the same issue when offshoring their IT projects as shown in Figure 1.

TABLE 3: RESPONSES BREAK DOWN BY CMM/CMMI MATURITY LEVEL AND MODEL

Maturity Level Achieved	CMMI-DEV/SVC (n=88)	CMMI-ACQ (n=82)	People-CMM (n=37)
Maturity Level 1	13.64%	18.29%	13.51%
Maturity Level 2	12.50%	12.20%	16.22%
Maturity Level 3	29.55%	19.51%	37.84%
Maturity Level 4	18.20%	29.27%	10.81%
Maturity Level 5	26.14%	20.73%	21.62%

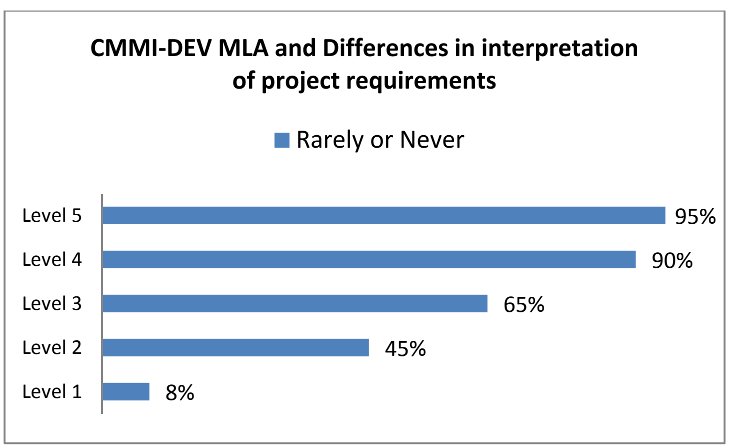

Figure 1: Results of CMMI DEV Maturity level achieved and IT offshoring issue of difference in interpretation of project requirements

C. Performing CMM/CMMI practices and IT offshoring issues

The investigation showed that the more frequently the IT offshoring company routinely performed the CMM/CMMI industry standards practices, reported fewer IT offshoring issues. The analysis showed a significant relationship between CMM/CMMI industry standards practices and the IT offshoring issues.

For example, Issue 1 of over expenditure due to hidden costs issue. The analysis showed a significant relationship between CMM/CMMI industry standards practices PR1 to PR6 and the IT offshoring issue 1 as shown in Figure 2. (84%) of the IT companies in our sample that Practiced PR1 (always or almost always) reported experiencing (rarely or never) fewer problems with the expenditure issue.

(5%) of the IT companies that practice PR1 (rarely or never) reported experiencing (rarely or never) problems with the expenditure issue.

D. Adopting CMM/CMMI models and IT offshoring project success

The investigation indicated that US IT companies that adopted CMM/CMMI models (CMMI-DEV/SVC, CMMI - ACQ, People-CMM or TSP) reported better results with their offshored projects on three factors: 1) Time/Schedule, 2) Cost/Budget and 3) Expected Quality.

V. CONCLUSION AND MAJOR FINDINGS

The investigation found that applying CMM/CMMI models and performing the industry best practices had a positive effect on managing and mitigating critical issues associated with offshore development.

The research major findings for IT offshoring companies:

Finding 1: Applying CMM/CMMI models have fewer issues associated with IT offshoring.

Finding 2: Achieving higher maturity levels of CMM/CMMI have fewer issues associated with IT offshoring.

Finding 3: Applying CMM/CMMI models and routinely performing industry practices have fewer issues associated with IT offshoring.

Finding 4: Applying CMM/CMMI models and routinely performing their industry practices have better project performance outcomes.

Finding 5: Utilizing and incorporating different practices from TSP and People into CMMI-DEV/SVC and CMMI-ACQ have fewer offshoring issues of language barriers and cultural differences.

Finding 6: Adopting and practicing CMM/CMMI models did not mitigate the offshoring issues of: 1) Time-zone difference between the client company and the supplier company and 2) Supplier security and political issues.

Hypothesis	Issues and CMM/CMMI Practices	Status
H3.1	Issue 1: OVER EXPENDITURE and CMM/CMMI Practices PR1 to PR6	
H3.1.1	PR1: Client Company establishes and maintains a project plan as the basis for managing the project	✓
H3.1.2	PR2: Client Company establishes and maintains the overall project plan.	✓
H3.1.3	PR3: Client Company estimates the project's effort and cost for work products and tasks based on estimation rationale	✓
H3.1.4	PR4: Client Company establishes and maintains the project's budget and schedule, milestones, constraints, dependencies	✓
H3.1.5	PR5: Client Company monitors off-shoring supplier project progress and performance (effort, and cost) as defined in the contract	✓
H3.1.6	PR6: Client Company manages invoices submitted by the supplier	✓

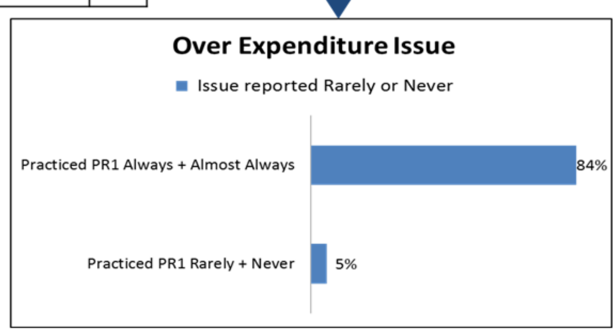

Figure 2: CMM/CMMI Practices and IT offshoring issues

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