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Abstract

This research investigated Capability Maturity Models (CMM) / Capability Maturity Model Integration (CMMI) best practices and their effects on managing and mitigating critical issues associated with offshore development. Using a web-based survey, data was collected from 451 Information Technology and software development firms in the US. The results of the analysis show that IT companies applying CMM/CMMI models have fewer issues associated with IT offshoring. When US IT companies utilizing and incorporating different practices from TSP and People-CMM into CMMI-DEV/SVC and CMMI-ACQ, they have fewer offshoring issues related to language barriers and cultural differences.

Keywords: Project Management; Strategic Management

1.Introduction

Offshoring is the outsourcing or/and insourcing of information technology (IT) work to a third party supplier located on a different continent than the client (Rottman and Lacity, 2008). The globalization of resources has resulted in a dramatic increase in offshoring. Although client companies have offshored manufacturing services for decades, the practice of offshoring IT services is still maturing. Offshoring is the transfer of an organizational function to another country, regardless of whether the work is outsourced to third party company (vendor) or stays within the same company (Trent and Monczka, 2005, Bhalla et al., 2008, Carmel and Agrawal, 2002b, Kakabadse and Kakabadse, 2002). Whereas Carmel defined Offshoring as performing work for clients in one country using workers located in a different country, this work may be outsourced to an offshore third party provider, or conducted by wholly or partially owned offshore subsidiaries of the onshore parent company (Carmel and Abbott, 2006).

The offshoring of IT services (primarily in India) will conservatively represent 25% of the global US\$ 1 trillion in 2014 (Kathpalia and Raman, 2014). Gartner reported that the top five Indian IT vendors namely

TCS, Cognizant, Infosys, Wipro and HCL Technologies grew 13.3 percent in 2012 to reach \$34.3 billion in 2012, exceeding global IT services industry growth rate of 2 percent. The North American markets currently contribute to roughly 70% of the revenue of the Indian IT service companies (Kathpalia and Raman, 2014). Many companies used offshoring strategies hoping to reduce costs (Williamson, 1985). On the other hand, contrary to popular perceptions, many companies have had mixed or diverse results. Half of the organizations that shifted processes offshore failed to generate the financial benefits they expected (Ferguson, 2004a, Lacity and Willcocks, 2001, Lacity and Willcocks, 1998, Lacity et al., 1996) and 50% of the offshoring contracts by North American companies signed between 2001 and 2004 are likely to fail to meet goals, according the predictions of both Gartner and Boston Consulting Group (Aron and J.Singh,2005). Gartner and Boston Consulting Group found that 50% of the offshoring contracts by North American companies fail to meet their expectations (Moe et al., 2013).

2. Literature Review

Although offshoring IT is technically possible because any work that can be digitized can be moved to an offshore supplier(s), there are many managerial challenges (Rottman and Lacity, 2008). One common complaint was that overall cost savings were less than anticipated due to the high transaction costs associated with finding suppliers, coordinating and monitoring the work done offshore (Ferguson, 2004b, Golder, 2004). Other common complaints were poor initial quality, late deliveries and personnel issues such as high supplier turnover that interfered with success (Lacity and Rottman, 2008). IT services contain a range of activities such as: software application development (web design development, e-commerce projects), database administration, software customization, IT calling centers, IT help desk support, software maintenance (remote software maintenance, feature enhancement), operations and facility management (Lacity and Rottman, 2008). IT service offshoring may either be a one-time limited-duration project or a long-term relationship. Offshoring poses additional challenges compared with domestic outsourcing (Rottman and Lacity, 2006). For example, offshoring is more challenging because of: time zone differences (Carmel, 2006), the need for more control (Chaudhury and Sabherwal, 2003, Choudhury and Sabherwal, 2003), cultural differences (Carmel and Tjia, 2005, Prikladnicki et al., 2003), defining requirements more rigorously (Chaudhury and Sabherwal, 2003, Gopal et al., 2003), the difficulties in managing dispersed teams (Oshri et al., 2008), and politically driven interests between the client and the service provider (Orlikowski, 2002).

Table 1: Forms of Outsource and Offshore Sourcing

| Forms | Types | Description |
|-------|-------|-------------|
| | | |

| | | |
|--------------------|--|---|
| In-sourcing | In-house (Lacity and Willcocks, 1998, Lacity et al., 2008, Metters, 2007) | The clients handle their own IT services and software development projects on their own premises in their home countries. |
| | Subsidiary (Lacity et al., 2008, Metters, 2007) Domestic captive (Lacity et al., 2008, Metters, 2007) | The client builds, owns, staffs, and operates facility in domestic locations in USA (Trent and Monczka, 2005, Carmel and Agrawal, 2002b). |
| | Captive service centers (Carmel and Beulen, 2005, Beulen et al., 2005) | Clients provide IT services from their own premises, employees, equipment, and facilities in domestic locations (Beulen et al., 2005). |
| | Types of Outsourcing | Description |
| Outsourcing | Outsourcing (Carmel and Agrawal, 2002b) IT outsourcing (Palvia, 1995) | Firms that outsource only domestically (Carmel and Agrawal, 2002b). An agreement in which one company hands over a part or all of their existing internal activity to another company through a contract (Hanna and Daim, 2009b). Contracting part or all of a firm's IT such as data processing, software, communication network, systems personnel or call centers to a third party vendor (Palvia, 1995). |
| | Outsourcing with domestic supplier (Lacity et al., 1996, Willcocks and Kern, 1998, Lacity et al., 2008) Outsourcing with multiple domestic suppliers (Lacity et al., 1996, Willcocks and Kern, 1998, Lacity et al., 2008, McFarlan and Nolan, 1995, Hoffmann, 1996) Outsourcing with in-state supplier (Lacity et al., 2008) On-shoring (Laplante et al., 2004) | Refers to a company contracting out of goods or services that were previously produced internally to a domestic third party company (Amiti and Wei, 2005, Lacity and Hirschheim, 1993b). The third party can be one or multiple domestic/national vendor or instate provider (McFarlan and Nolan, 1995, Hoffmann, 1996). Onshore represent outsourcing to domestic supplier (Laplante et al., 2004). |
| | Total outsourcing (Lacity and Willcocks, 1998) Complete outsourcing (Allen and Chandrashekar, 2000) | Contract out more than 80% of the work to an external domestic provider while retaining the management (Lacity and Willcocks, 1998). The transfer of the entire business functions from the outsourcing company to the outsourcing vendor (Allen and Chandrashekar, 2000). |
| | Total in-sourcing (Lacity and Willcocks, 1998) In-sourcing - contracting-in (Lacity et al., 1996) Fee-for-service contracts (Bhalla et al., 2008, Carmel and Agrawal, 2002b) | Execute work internally (Lacity and Willcocks, 1998). The delegation of operations or jobs from production within a business to an internal (but 'stand-alone') entity that specializes in that job (Lacity et al., 1996). In-sourcing is a business decision that is often made to maintain control of critical production or competencies. An alternate use of the term implies transferring jobs to within the country where the term is used, either by hiring local subcontractors or building a facility (Hirschheim and Lacity, 2000). |
| | Selective outsourcing – smart sourcing – right sourcing (Lacity and Willcocks, 1998) | Outsource selected processes while still executing internally between 20% and 80%. The company may outsource to single or multiple vendors (Lacity and Willcocks, 1998). |
| | Business process outsourcing (BPO) (Halvey and Melby, 2007, Yang et al., 2007) | The biggest difference between outsourcing and BPO is that the BPO third party vendor providers control all issues related to business processes, human resources and technology (Yang et al., 2007). |
| | Offshoring: Multinational company | Multinational company outsourcing Consultancy companies (Schwalbe, 2010) Multinational enterprises (MNEs) |

| | | |
|--------------------|--|--|
| | Value Centers (Trent and Monczka, 2005), Profit value centers (Venkatraman, 1997). | The customer owns and runs the facility as a profit center, offering services to other international companies (Trent and Monczka, 2005, Venkatraman, 1997). |
| | “Greenfield” subsidiaries (Niosi and Tschang, 2009) | A form of foreign direct investment where a parent company in a developing country starts a new venture in a developed foreign country from the ground up (Niosi and Tschang, 2009). |
| | Body-shopping (Majumdar et al., 2011) | On-shore temporary hiring from a multinational such as (Indian) firm. Onsite consultancy performed at clients’ premises, involving software professionals who act as temporary employees of clients. For international clients, body-shopping keeps work within their home nations and premises. Clients’ demand determines how much body-shopping is needed (Majumdar et al., 2011). Normally these services are provided by U.S. domestic subsidiaries of multinational companies (Lacity and Willcocks, 1995) . |
| | Types of off-shoring | Description |
| Off-shoring | Near-shore (Laplante et al., 2004) | Relocation of business processes to (classically) lower cost foreign locations, but in close geographical proximity (e.g., shifting United States-based business processes to Canada/Latin America) (Carmel and Abbott, 2006, Carmel, 1999, Carmel, 2007, Bock, 2008, Laplante et al., 2004). |
| | Far-shore/Offshore | Near-shoring, far-shoring and offshoring refer to the fact that some of the duties belonging to software projects are sourced out to a lower-wage country (Aspray et al., 2006). Whether the term off or near-shoring seems to be a matter of distance (Carmel and Abbott, 2006). Offshoring is associated with countries being “far away,” referring to a distance of more than 1000 kilometers (e. 621 miles) or few hours flight away (Carmel and Abbott, 2006, Carmel, 2007). |
| | Dedicated offshore outsourcing (Trent and Monczka, 2005, Carmel and Agrawal, 2002b, Palvia, 1995), Fully owned facility (Leiblein et al., 2002) | The offshore vendor owning the operation dedicated part of its facility to the customer (Trent and Monczka, 2005, Carmel and Agrawal, 2002b, Leiblein et al., 2002, Palvia, 1995). |
| | Built-operate-transfer (BOT) (Trent and Monczka, 2005, Carmel and Agrawal, 2002b, Colombo, 2003), Strategic alliances/ partnerships (Lacity and Willcocks, 1998) | BOT forms a hybrid between dedicated and captive facilities. The company forms a strategic alliance with an offshoring vendor to set-up and manage an offshore facility with an option to own the facility after the expiration of a specified period (Bhalla et al., 2008, Carmel and Agrawal, 2002b, Colombo, 2003). |
| | Offshore in-sourcing Captive model (Trent and Monczka, 2005), Wholly owned offshore Captive center (Carmel and Agrawal, 2002b). Subsidiary, Offshore in-sourcing, Global in-sourcing | The client builds, owns, staffs, and operates the offshore facility (Trent and Monczka, 2005, Carmel and Agrawal, 2002b). The company owns and establishes offshore IT centers where foreign technologies workers are employees of U.S. based companies and receive the same training, software tools, and development process guidelines as their western counterparts (Carmel and Agrawal, 2002b, Rao, 2004). |

| | Types of Offshore Outsourcing | Description |
|----------------------|---|---|
| Offshore Outsourcing | Offshore outsourcing (Hanna and Daim, 2009b, Trent and Monczka, 2005, Michell and Fitzgerald, 1997) Global outsourcing International outsourcing (Carmel and Agrawal, 2002b, Amity and Wei, 2005) | A contract or agreement with the vendor for his services. The company offshore outsources one or more project based on a contract(s) for a fixed cost and depending on identified deliverables and time schedules (Hanna and Daim, 2009b, Rivard and Aubert, 2007). The offshore vendor owns, builds, staffs and operates the facility on behalf of the customer (Trent and Monczka, 2005, Lacity and Willcocks, 1998, Michell and Fitzgerald, 1997). |

CMM/CMMI in software engineering and organizational development is a process improvement approach that provides organizations with the essential elements for effective process improvement. CMM/CMMI can be used to guide process improvement across a project, a division or an entire organization (2010b). 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 (2010c, 2010a).

CMMI tools minimize the risks of outsourcing projects of government and industrial companies (Harter et al., 2000). Research shows that it has proven to increase productivity and the quality of outsourced projects (Harter et al., 2000). Research studies have consistently shown results regarding improved productivity, increased quality and reductions in cycle time (Herbsleb and Grinter, 1999, Harter et al., 2000, Curtis et al., 2001, Curtis et al., 2010) . CMMI for Acquisition (CMMI-ACQ) helps client companies improve relationships with their suppliers by assisting client companies improve their own processes. Research based on case studies and interviews with experts support the People CMM approach as a key tool of managing an organization’s total performance and evidence indicates that the People CMM improves teamwork, communication and knowledge levels (Vakaslahti, 1998). Since its release in 1995, thousands of copies of the People CMM have been distributed worldwide and were used by organizations small and large such as: IBM, Boeing, BAE Systems, Tata Consultancy Services, Ericsson, Lockheed Martin and QAI (India) Ltd.

The practices of Team Software Process (TSP) help create a team of software developers that can build a quality product on time, on budget and where the team is still functional after the product is built. According to Humphrey, the Team Software Process (TSP) is designed to build and manage quality software teams (Humphrey, 2002). They attributed this rapid pace of improvement to the organization’s prior introduction and adaptation of the TSP (Humphrey et al., 2003). The CMM/CMMI model requires a considerable amount of time, money and effort to implement and often requires a major shift in the culture and attitude in the organizations that decide to apply it (Brooks, 1987, Ibbs and Kwak, 2000, Jiang et al., 2004). One study in the US software sector found that the median time for an organization to move up one level of the five-level CMM/CMMI is between 21 and 37 months (Herbsleb et al., 1997b). Over three-quarters of the organizations

reported that implementing any Specific Practice (SP) activity took longer than expected. In addition, an organization's culture can be adversely impacted by adding to CMMI rigid bureaucracy and reducing the creativity and freedom of the developers (Jones, 1995). Researchers such as Johansen, Mathiassen, Nielsen and Borbjerg have suggested that CMM/CMMI does not effectively deal with the social aspects of IT organizations. Johansen and Mathiassen (Johansen and Mathiassen, 1998) argue that CMM/CMMI needs a more managerial focus. Nielsen and Nørbjerg (Iversen et al., 2002) argue that CMM needs to be supplemented with socially oriented theories in order to address organizational change issues and organizational politics. Aaen (Aaen et al., 2001) argue that the scale and complexity of the organizational change proposed by CMM necessitates a managerial rather than technical approach.

Although these process improvement approaches were originally developed as methods for the objective evaluation of contractors for military software projects (*outsourcing*) and were not designed with *offshoring* development in mind, they are widely adapted and have received great publicity in the software development industry (Biberoglu and Haddad, 2002, Fitzgerald and O'Kane, 1999, Jiang et al., 2004, Amberg and Wiener, 2005, Dubey, 2003, Meyer, 2006, Gibson et al., 2006). However, the literature also shows that 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 (Sengupta et al., 2006b, Lasser and Heiss, 2005, Prikladnicki et al., 2007, Ebert, 2007, Ebert et al., 2008, Gopal et al., 2002b).

Maturity models have also been developed or studied for other functions: project management maturity in industrial companies (Spalek, 2015); sustainable operations management (Machado et al, 2017); enterprise maturity in production management (Kosieradzka, 2017); portfolio management Nikkhou et al (2016); project management (de Souza et al, 2015; Tahri and Drissi-Kaitouni, 2015); energy management (Finnerty et al, 2017; Jovanović and Filipović, 2016); integrated management systems (Domingues et al, 2016); remanufacturing process capability (Butzer et al, 2017); learning factories (Enke et al 2017); IT based case management (Koehler et al, 2015); staged models (Uskarcı and Demirörs, 2017). CMM/CMMI models and best practices, to mitigate the issues and challenges of offshoring IT services and software development projects, has not been adequately investigated and most evidence is anecdotal.

Research Questions:

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

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

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

3. Methodology

Based on the literature review, the research questions and hypotheses were formed, the questionnaire was designed and two expert panels were formed: 1) CMM/CMMI IT service offshoring expert panel and 2) IT service offshoring expert panel with no CMM/CMMI experience. Testing and validation of the questionnaire were applied with various iterations were performed to get the final version of the questionnaire. Data were collected; then the analysis phase started, followed by results, discussion and interpretation. The following hypotheses were developed for this research:

1. *There is a relationship between adopting CMM/CMMI and the frequency of issues experienced by client firms when offshoring IT service projects.*
2. *There is a relationship between the CMM/CMMI maturity level achieved and the frequency of issues experienced by firms when offshoring IT service projects.*
3. *There is a relationship between CMM/CMMI practices and the frequency of issues experienced by firms when offshoring IT service projects.*

The hypotheses were derived from the research questions. The first hypothesis aimed to test the relationship between adopting industrial standards and the frequency of issues experienced by the client firms when offshoring IT service projects. The second hypothesis is aimed at testing the relationship between the maturity level achieved and the frequency of issues experienced by client firm when offshoring IT service projects. The third hypothesis is intended to test the relationship between adopting industrial standards best practices and the frequency of issues experienced by client firms when offshoring IT service projects.

Internet-based surveys (email, web survey) are becoming increasingly popular because they are believed to be faster, better, cheaper and easier to conduct than surveys using more-traditional telephone or mail methods (Reynolds et al., 2006, Sue and Ritter, 2007, Schonlau et al., 2002). A standard survey instrument (Cooper and Pamela, 2008, Cooper and Schindler, 2006, Graziano and Raulin, 2006, Zikmund and Zihmund, 1999) will help to collect data for analysis utilizing Chi-square for testing the hypotheses (Hair et al., 1992, Hair et al., 1995, Dillon and Goldstein, 1984, Johnson and Wichern, 1992). The Kompass database was used to build the database of target 12,000 IT companies (www.Us.kompass.com). At the conclusion of data collection, 316 valid responses were considered for this research, 558 (6.14% response rate) responses were received, 451 completed responses, 371 responses offshored their IT projects and 55 responses were excluded from the analyses for companies used other quality assurance models. In this manner, their results will not affect our data analysis.

4. Results

A growing number of organizations are adopting the Software Engineering Institutes' (SEI) Capability Maturity Model (CMM) and Capability Maturity Model Integrate (CMMI) to improve their IT service and software development process. CMM/CMMI became an industry standard based on industry best practices and features an industry standard appraisal methods (Olson, 2008, Dubey, 2003). This research examined four CMM/CMMI models: 1) CMMI for Development/Services; 2) CMMI for Acquisition; 3) People-CMM; Team Software Process (TSP). Little is known regarding how adopting CMM/CMMI influences the frequency of IT offshoring issues experienced by the client companies. This research investigated CMM/CMMI best practices and their effect on managing and mitigating critical issues associated with offshore development.

Table 2: Summary of H1.1 adopting CMMI for DEV/SVC and offshoring issues

| Hypothesis 1.1 | | *Status Significantly Associated | Strength of Association |
|--|---|---|--------------------------------|
| There is a relationship between adopting CMMI-DEV/SVC and | | | |
| H1.1.1 | Over expenditure issue. | Yes | 0.610 |
| H1.1.2 | Poor execution plan specifically timing and type of work transferred to the supplier issue. | Yes | 0.707 |
| H1.1.3 | Difference in interpretation of project requirements between Client company and the supplier. | Yes | 0.659 |
| H1.1.4 | Poorly developed and documented requirements by the client company. | Yes | 0.685 |
| H1.1.5 | Poor tracking and managing requirement changes by the client company. | Yes | 0.681 |
| H1.1.6 | Lack of a full communication plan between the client company and the supplier company. | Yes | 0.641 |
| H1.1.7 | Communication and coordination problems between the client company and the supplier company. | Yes | 0.703 |
| H1.1.8 | Language barriers between the client company and the supplier. | No | 0 |
| H1.1.9 | Time-zone differences between the client company and the supplier. | No | 0 |
| H1.1.10 | Cultural differences between the client company and the supplier. | No | 0 |
| H1.1.11 | Incomplete and unclear contract. | Yes | 0.617 |
| H1.1.12 | Early contract renegotiation and termination. | Yes | 0.589 |
| H1.1.13 | Difference in project management practices between your company and the supplier. | Yes | 0.639 |
| H1.1.14 | Client company unable to measure the performance of the supplier. | Yes | 0.672 |
| H1.1.15 | Supplier technical/security and political issues. | No | 0 |
| H1.1.16 | Insufficient previous experience of the supplier. | Yes | 0.645 |
| H1.1.17 | Lack of supplier standardized working methods. | Yes | 0.626 |
| *P=.05/68 = 0.0007352 (Bonferroni Adjustment) | | | |

The analysis of hypothesis 1 showed a statistically associated relationship between adopting CMMI for DEV/SVC and CMMI for ACQ models and IT offshoring issues (77%). However, the results did not show a significant relationship with 25% of the IT offshoring issues of Language Barriers, Time-zone Differences, Cultural Differences and Supplier Political and Security issues. Therefore, this may suggest, consistent with the literature, that IT services and software development offshoring projects pose significant issues and challenges to the client companies in managing these projects (Ebert et al., 2008). In IT service offshoring; delivery occurs under the additional condition of distance between the service supplier and the client in terms of physical distance, time zone differences or cultural differences. Additionally, complexity

increases due to the higher degree of geographical dispersion among team members (Holmström et al., 2008, Yalaho and Nahar, 2009, McIvor, 2000, Raffo and Setamanit, 2005). Therefore, there is a need to utilize different methods to effectively and efficiently mitigate the issues and challenges of offshoring.

Hypotheses 1.2, 1.3 and 1.4 analyses showed surprising results (Tables 3-5). There was a statistically association relationship between adopting People-CMM and TSP and language barriers and cultural differences between the client company and the supplier company. Whereas, these two issues did not show a significance when adopting CMMI for DEV/SVC and CMMI for ACQ that are mostly adopted by IT offshoring companies. This may suggest that there is a need to utilize and incorporate different practices from TSP and People along with CMMI for DEV/SVC and CMMI for ACQ to effectively and efficiently mitigate the issues of Language Barriers and Cultural Differences.

Table 3: Summary of H1.2 Adopting CMMI for Acquisition and Offshoring Issues

| Hypothesis 1.2 | | *Status Significantly Associated | Strength of Association |
|--|--|---|--------------------------------|
| There is a relationship between adopting CMMI for Acquisition and | | | |
| H1.2.1 | Over expenditure issue. | Yes | 0.769 |
| H1.2.2 | Frequency of poor execution plan | Yes | 0.609 |
| H1.2.3 | Difference in interpretation of project requirements | Yes | 0.542 |
| H1.2.4 | Poorly developed and documented requirements | Yes | 0.532 |
| H1.2.5 | Poor tracking and managing requirement changes | Yes | 0.566 |
| H1.2.6 | Lack of a full communication plan | Yes | 0.545 |
| H1.2.7 | Communication and coordination problems | Yes | 0.613 |
| H1.2.8 | Language barriers | No | 0 |
| H1.2.9 | Time-zone differences | No | 0 |
| H1.2.10 | Cultural differences | No | 0 |
| H1.2.11 | Incomplete and unclear contract issue. | Yes | 0.498 |
| H1.2.12 | Early contract renegotiation and termination issue. | Yes | 0.642 |
| H1.2.13 | Difference in project management practices | Yes | 0.474 |
| H1.2.14 | Unable to measure the performance of the supplier issue. | Yes | 0.584 |
| H1.2.15 | Supplier security and political issues. | No | 0 |
| H1.2.16 | Insufficient previous experience of the supplier issue. | Yes | 0.624 |
| H1.2.17 | Lack of supplier standardized working methods issue. | Yes | 0.645 |
| *P=.05/68 = 0.0007352 (Bonferroni's Adjustment) | | | |

Table 4: Summary of H1.3 adopting People-CMM and IT Offshoring Issues

| Hypothesis 1.3 | | *Status Significantly Associated | Strength of Association |
|--|--|---|--------------------------------|
| There is a relationship between adopting People-CMM and | | | |
| H1.3.1 | Over expenditure issue. | No | 0 |
| H1.3.2 | Poor execution plan | Yes | .307 |
| H1.3.3 | Difference in interpretation of project requirements. | Yes | .427 |
| H1.3.4 | Poorly developed and documented requirements by client company. | Yes | .382 |
| H1.3.5 | Poor tracking and managing requirement changes. | Yes | .342 |
| H1.3.6 | Lack of a full communication plan. | Yes | .499 |
| H1.3.7 | Communication and coordination problems. | Yes | .453 |
| H1.3.8 | Language barriers between the client and supplier. | Yes | .387 |
| H1.3.9 | Time-zone differences between the client company and the supplier. | No | 0 |
| H1.3.10 | Cultural differences between the client company and the supplier | Yes | .413 |
| H1.3.11 | Incomplete and unclear contract issue. | Yes | .335 |
| H1.3.12 | Early contract renegotiation and termination issue. | No | 0 |
| H1.3.13 | Difference in project management practices. | No | 0 |

| | | | |
|---|---|-----|------|
| H1.3.14 | Unable to measure the performance of the supplier. | No | 0 |
| H1.3.15 | Supplier technical/security and political issues. | No | 0 |
| H1.3.16 | Insufficient previous experience of the supplier issue. | Yes | .314 |
| H1.3.17 | Lack of supplier standardized working methods issue. | Yes | .296 |
| *P=.05/68 = 0.0007352 (Bonferroni's Adjustment) | | | |

Table 5: Summary of H1.4 Adopting (TSP) and IT Offshoring Issues

| Hypothesis 1.4 | | *Status Significantly Associated | Strength of Association |
|---|--|----------------------------------|-------------------------|
| There is a relationship between adopting TSP and | | | |
| H1.4.1 | Over expenditure. | No | 0 |
| H1.4.2 | Poor execution plan. | Yes | 0.304 |
| H1.4.3 | Difference in interpretation of project requirements. | Yes | 0.384 |
| H1.4.4 | Poorly developed and documented requirements. | Yes | 0.304 |
| H1.4.5 | Poor tracking and managing requirement changes. | Yes | 0.324 |
| H1.4.6 | Lack of a full communication plan. | Yes | 0.464 |
| H1.4.7 | Communication and coordination problems. | Yes | 0.424 |
| H1.4.8 | Language barriers | Yes | 0.517 |
| H1.4.9 | Time-zone differences | No | 0 |
| H1.4.10 | Cultural differences | Yes | 0.492 |
| H1.4.11 | Incomplete and unclear contract issue. | Yes | 0.303 |
| H1.4.12 | Early contract renegotiation and termination issue. | Yes | 0.304 |
| H1.4.13 | Difference in project management practices. | No | 0 |
| H1.4.14 | Unable to measure the performance of the supplier issue. | No | 0 |
| H1.4.15 | Supplier security and political issues. | No | 0 |
| H1.4.16 | Insufficient previous experience of the supplier issue. | No | 0 |
| H1.4.17 | Lack of supplier standardized working methods issue. | No | 0 |
| *P=.05/68 = 0.0007352 (Bonferroni's Adjustment) | | | |

On the other hand, the analysis of hypothesis 2 showed a statistical significance between adopting CMMI for DEV/SVC and CMMI for ACQ maturity levels achieved and IT offshoring issues (77%) (Tables 6-8).

Table 6: H2.1-CMMI-DEV/SVC Maturity Level Achieved and IT Offshoring Issues

| Hypothesis 2.1 | | *Status Significantly Associated | Strength of Association |
|---|---|----------------------------------|-------------------------|
| There is a relationship between CMMI-DEV/SVC ML achieved and | | | |
| H2.1.1 | Over expenditure issue. | Yes | 0.769 |
| H2.1.2 | Poor execution plan specifically timing. | Yes | 0.609 |
| H2.1.3 | Difference in interpretation of project requirements. | Yes | 0.542 |
| H2.1.4 | Poorly developed and documented requirements. | Yes | 0.532 |
| H2.1.5 | Poor tracking and managing requirement changes. | Yes | 0.566 |
| H2.1.6 | Lack of a full communication plan. | Yes | 0.545 |
| H2.1.7 | Communication and coordination problems. | Yes | 0.613 |
| H2.1.8 | Language barriers between client and supplier. | No | 0 |
| H2.1.9 | Time-zone differences. | No | 0 |
| H2.1.10 | Cultural differences. | No | 0 |
| H2.1.11 | Incomplete and unclear contract issue. | Yes | 0.498 |
| H2.1.12 | Early contract renegotiation and termination issue. | Yes | 0.642 |
| H2.1.13 | Difference in project management practices. | Yes | 0.474 |
| H2.1.14 | Unable to measure the performance of supplier. | Yes | 0.584 |
| H2.1.15 | Supplier technical/security and political issues. | No | 0 |
| H2.1.16 | Insufficient previous experience of supplier. | Yes | 0.624 |
| H2.1.17 | Lack of supplier standardized working methods. | Yes | 0.645 |
| *P=.05/51 (17*3) = 0.00098039 (Bonferroni's Adjustment) | | | |

Table 7: H2.2 -CMMI-ACQ Maturity Level (ML) Achieved and IT Offshoring Issues

| Hypothesis 2.2 There is a relationship between adopting CMMI-ACQ ML achieved and | | *Status Significantly Associated | Strength of Association |
|---|---|---|--------------------------------|
| H2.2.1 | Over expenditure issue. | Yes | 0.769 |
| H2.2.2 | Poor execution plan. | Yes | 0.609 |
| H2.2.3 | Difference in interpretation of project requirements. | Yes | 0.542 |
| H2.2.4 | Poorly developed and documented requirements. | Yes | 0.532 |
| H2.2.5 | Poor tracking and managing requirement changes. | Yes | 0.566 |
| H2.2.6 | Lack of a full communication plan. | Yes | 0.545 |
| H2.2.7 | Communication and coordination problems. | Yes | 0.613 |
| H2.2.8 | Language barriers between client company and supplier. | No | 0 |
| H2.2.9 | Time-zone differences. | No | 0 |
| H2.2.10 | Cultural differences. | No | 0 |
| H2.2.11 | Incomplete and unclear contract issue. | Yes | 0.498 |
| H2.2.12 | Early contract renegotiation and termination. | Yes | 0.642 |
| H2.2.13 | Difference in project management. | Yes | 0.474 |
| H2.2.14 | Unable to measure performance of supplier. | Yes | 0.584 |
| H2.2.15 | Supplier technical/security and political issues. | No | 0 |
| H2.2.16 | Insufficient previous experience of the supplier issue. | Yes | 0.502 |
| H2.2.17 | Lack of supplier standardized working methods. | Yes | 0.498 |
| *P=.05/51 (17*3) = 0.00098039 (Bonferroni's Adjustment) | | | |

Table 8: H2.3 - People-CMM Maturity Level Achieved and IT Offshoring Issues

| Hypothesis 2.3 There is a relationship between adopting People-CMM ML achieved and the | | **Status Significantly Associated |
|---|---|--|
| H2.3.1 | Over expenditure issue. | No |
| H2.3.2 | Poor execution plan. | *No |
| H2.3.3 | Difference in interpretation of project requirements. | *No |
| H2.3.4 | Poorly developed and documented requirements by the client company issue. | *No |
| H2.3.5 | Poor tracking and managing requirement changes by client company issue. | *No |
| H2.3.6 | Lack of a full communication plan issue. | *No |
| H2.3.7 | Communication and coordination problems. | *No |
| H2.3.8 | Language barriers between the client company and the supplier issue. | *No |
| H2.3.9 | Time-zone differences. | *No |
| H2.3.10 | Cultural differences. | *No |
| H2.3.11 | Incomplete and unclear contract issue. | *No |
| H2.3.12 | Contract renegotiation and termination issue. | *No |
| H2.3.13 | Difference in project management practices between client and supplier. | No |
| H2.3.14 | Unable to measure the performance of the supplier issue. | *No |
| H2.3.15 | Supplier technical/security and political issues. | *No |
| H2.3.16 | Insufficient previous experience of the supplier issue. | *No |
| H2.3.17 | Lack of supplier standardized working methods. | *No |
| *Results may differ with more data (small sample 36 valid cases) | | |
| **P=.05/51 (17*3) = 0.00098039 (Bonferroni's Adjustment) | | |

The investigation for hypothesis 3 showed that the more frequently the IT offshoring company routinely performed the CMM/CMMI industry standard practices they reported fewer issue with IT offshoring issues (Table 9). The analysis showed a significant relationship between CMM/CMMI industry standards practices and the IT offshoring issues (92%).

Table 9: H3.1 Results of the practices and IT offshoring issues

| Hypothesis | Issues and CMM/CMMI Practices | *Status Significantly Associated | Strength of Association |
|------------|--|----------------------------------|-------------------------|
| H3.1 | Issue 1: OVER EXPENDITURE and CMM/CMMI Practices PR1 to PR6 | | |
| H3.1.1 | PR1: Establishes and maintains a project plan as the basis for managing the project | Yes | 0.611 |
| H3.1.2 | PR2: Establishes and maintains the overall project plan. | Yes | 0.692 |
| H3.1.3 | PR3: Estimates the project's effort and cost for work products and tasks based on estimation rationale | Yes | 0.651 |
| H3.1.4 | PR4: Establishes and maintains the project's budget and schedule, milestones, constraints, dependencies | Yes | 0.591 |
| H3.1.5 | PR5: Monitors offshoring supplier project progress and performance (effort, and cost) as defined in the contract | Yes | 0.606 |
| H3.1.6 | PR6: Manages invoices submitted by the supplier | Yes | 0.541 |
| H3.2 | Issue 2: DIFFERENCES IN INTERPRETATION OF PROJECT REQUIREMENTS BETWEEN THE CLIENT AND THE SUPPLIER and CMM/CMMI Practices PR7 to PR9 | | Strength of Association |
| H3.2.1 | PR7: Develops an understanding with offshoring supplier on the meaning of requirement | Yes | 0.451 |
| H3.2.2 | PR8: Validates requirements to ensure that the resulting product performs as intended in the end user's environment | Yes | 0.525 |
| H3.2.3 | PR9: Obtains commitment to requirements from project participants | Yes | 0.446 |
| H3.3 | Issue 3: POORLY DEVELOPED AND DOCUMENTED REQUIREMENTS BY THE CLIENT COMPANY and CMM/CMMI Practices PR10 and PR11 | | Strength of Association |
| H3.3.1 | PR10: Stakeholder needs, expectations, constraints and interfaces are collected and translated into customer requirements | Yes | 0.561 |
| H3.3.2 | PR11: Maintains bidirectional traceability among requirements and work products | Yes | 0.651 |
| H3.4 | Issue 4: POOR TRACKING AND MANAGING REQUIREMENT CHANGES BY CLIENT COMPANY and PR12 to PR14 | | Strength of Association |
| H3.4.1 | PR12: Manages changes to requirements as they evolve during the project. | Yes | 0.640 |
| H3.4.2 | PR13: Ensures that project plans and work products remain aligned with requirements | Yes | 0.614 |
| H3.4.3 | PR14: Customer Interface Manager leads the team in estimating and documenting the impact of every change in requirement and works with the Configuration Control Board (CCB) to get approval for changes to those requirements | Yes | 0.657 |
| H3.5 | Issue 5: LACK OF A FULL COMMUNICATION PLAN BETWEEN THE CLIENT AND THE SUPPLIER and PR15 to PR19 | | Strength of Association |
| H3.5.1 | PR15: Establishes and manages the coordination and collaboration between the project and relevant stakeholders | Yes | 0.655 |

| | | | |
|--------|---|-----|-------------------------|
| H3.5.2 | PR16: Team members track actual results and performance against plans on a weekly basis. Team members track progress against individual plans on a daily basis. | Yes | 0.693 |
| H3.5.3 | PR17: Develops a documented plan to be used to communicate group commitments and to coordinate and track work performed. | Yes | 0.646 |
| H3.5.4 | PR18: Team managers are responsible for coordination across all project teams | Yes | 0.677 |
| H3.5.5 | PR19: Communication and coordination practices are institutionalized to ensure are performed as managed processes | Yes | 0.635 |
| H3.6 | Issue 6: COMMUNICATION AND COORDINATION PROBLEMS BETWEEN THE CLIENT AND THE SUPPLIER and CMM/CMMI Practices PR20 to PR23 | | Strength of Association |
| H3.6.1 | PR20: Representatives of the client company project's software engineering group work with representatives of the supplier engineering groups to monitor and coordinate technical activities and resolve technical issues | Yes | 0.515 |

| | | | |
|-----------|--|--------------------------------|----------------------------------|
| H3.6.2 | PR21: Selects team roles, including the role of Supplier Interface Manager, who is the liaison between the team and the supplier company representative, and is responsible for requirements change management | Yes | 0.411 |
| H3.6.3 | PR22: Communicates quality issues and ensures the resolution of noncompliance issues with the staff and managers | Yes | 0.601 |
| H3.6.4 | PR23: Establishes and maintains a documented policy for conducting its Communication and Coordination activities | Yes | 0.549 |
| H3.7 | Issues: 7) LANGUAGE BARRIERS 8) TIME-ZONE DIFFERENCES 9) CULTURAL DIFFERENCES BETWEEN THE CLIENT AND THE SUPPLIER and CMM/CMMI Practices PR24 to PR29 | | Strength of Association |
| H3.7.1a-c | PR24: Client Company ensures that the workforce has the skills to share information and coordinate their activities efficiently | Yes Language + Cultural | .458 Language .411 -Cultural |
| H3.7.2a-c | PR25: Client Company establishes a culture for openly sharing information and concerns across organizational levels as well as among team members | Yes (Language, Cultural) | .400 -Language .395 -Cultural |
| H3.7.3a-c | PR26: Client Company establishes project teams as well as their responsibilities, authorities and interrelationships | Yes (Language, Cultural) | .438 -Language .447 -Cultural |
| H3.7.4a-c | PR27: Client Company establishes and maintains open and effective project teams' communication and coordination plan | Yes (Language, Cultural) | .455 Language .465 -Cultural |
| H3.7.5a-c | PR28: Client Company team managers are responsible to track and resolve inter-group issues | Yes (Language, Cultural) | .422 Language .326 -Cultural |
| H3.7.6a-c | PR29: Maintains effective work-groups, interpersonal problems are addressed quickly and meetings are managed to ensure that work-group time is used most effectively | Yes (Language, Cultural) | .402 Language .367- Cultural |
| H3.8 | Issue 10: INCOMPLETE AND UNCLEAR CONTRACT and CMM/CMMI Practices PR30 to PR34 | | |
| H3.8.1 | PR30: Establishes and maintains a mutual understanding of the contract with selected suppliers and end users. | Yes | 0.660 |
| H3.8.2 | PR31: Stakeholder needs, expectations, constraints and interfaces are collected and translated into customer requirements. | Yes | 0.581 |
| H3.8.3 | PR32: Requirements are refined and elaborated into contractual requirements. | Yes | 0.537 |
| H3.8.4 | PR33: Establishes and maintains formal contract management plan | Yes | 0.539 |
| H3.8.5 | PR34: Establishes and maintains contractual requirements. | Yes | 0.490 |
| H3.9 | Issue 11: EARLY CONTRACT RENEGOTIATION AND TERMINATION and CMM/CMMI Practices PR35 and PR36 | | |
| H3.9.1 | PR35: Establishes and maintains negotiation plans to use in completing a supplier agreement. | Yes | 0.453 |
| H3.9.2 | PR36: Insures that agreements with suppliers are satisfied by both the project and the supplier. | Yes | 0.566 |
| H3.10 | Issue 12: INSUFFICIENT PREVIOUS EXPERIENCE OF THE SUPPLIER and CMM/CMMI Practices PR37 to PR39 | | Strength of Association |
| H3.10.1 | PR37: Selects suppliers based on an evaluation of their ability to meet specified requirements and established criteria | Yes | 0.520 |
| H3.10.2 | PR38: Client Company identifies and qualifies potential suppliers | Yes | 0.537 |
| H3.10.3 | PR39: Selects suppliers using a formal evaluation | Yes | 0.655 |
| H3.11 | Issue 13: UNABLE TO MEASURE PERFORMANCE OF THE SUPPLIER and CMM/CMMI Practices PR40 to PR48 | | Strength of Association |
| H3.11.1 | PR40: Establishes and maintains quantitative objectives to address quality and process performance, based on customer needs and business objectives. | Yes | 0.486 |
| H3.11.2 | PR41: Manages the project using statistical and other quantitative techniques to determine whether or not the project's objectives for quality and process performance will be satisfied. | Yes | 0.507 |

| | | | |
|--|--|-----|-------------------------|
| H3.11.3 | PR42: Performs root cause analysis of selected issues to address deficiencies in achieving the project's quality and process performance objectives. | Yes | 0.470 |
| H3.11.4 | PR43: Manages corrective actions to closure when the project's performance or results deviate significantly from the plan | Yes | 0.520 |
| H3.11.5 | PR44: Periodically reviews the project's progress, performance and issues experienced. | Yes | 0.537 |
| H3.11.6 | PR45: Reviews the project's accomplishments and results at selected project milestones. | Yes | 0.489 |
| H3.11.7 | PR46: Establishes and maintains records of quality assurance activities. | Yes | 0.580 |
| H3.11.8 | PR47: Monitors the actual project performance and progress against the project plan | Yes | 0.452 |
| H3.11.9 | PR48: Ensures that the supplier agreement is satisfied before accepting the acquired product | Yes | 0.465 |
| H3.12 | Issue 14: SUPPLIER TECHNICAL/SECURITY /POLITICAL ISSUES and CMM/CMMI Practices PR49 to PR51 | | Strength of Association |
| H3.12.1 | PR49: Selects supplier technical solutions to be analyzed and analysis methods to be used. | Yes | 0.400 |
| H3.12.2 | PR50: Conducts technical reviews with the supplier as defined in the supplier agreement. | Yes | 0.446 |
| H3.12.3 | PR51: Evaluates and categorizes each identified issue using defined risk categories and determines its relative priority. | Yes | 0.305 |
| H3.13 | Issue 15: DIFFERENCE IN PROJECT MANAGEMENT PRACTICES BETWEEN THE CLIENT AND THE SUPPLIER and the CMM/CMMI Practices PR52 to PR56 | | Strength of Association |
| H3.13.1 | PR52: Selects suppliers based on an evaluation of their ability to meet specified requirements and established criteria | Yes | 0.491 |
| H3.13.2 | PR53: Identifies and qualifies potential suppliers | Yes | 0.547 |
| H3.13.3 | PR54: Selects, monitors, and analyzes supplier processes | Yes | 0.607 |
| H3.13.4 | PR55: Selects suppliers using a formal evaluation | Yes | 0.607 |
| H3.13.5 | PR56: Establishes and maintains a usable set of organizational process assets, work environment standards, rules for teams | Yes | 0.538 |
| H3.14 | Issue 16: POOR EXECUTION PLAN SPECIFICALLY TIMING AND TYPE OF WORK TRANSFERRED TO THE SUPPLIER and CMM/CMMI Practices PR57 to PR60 | | Strength of Association |
| H3.14.1 | PR57: Establishes and maintains the offshoring strategy | Yes | 0.507 |
| H3.14.2 | PR58: Establishes and maintains plan for performing offshoring | Yes | 0.507 |
| H3.14.3 | PR59: Determines the type of acquisition for each product | Yes | 0.476 |
| H3.14.4 | PR60: Plan transition to operations | Yes | 0.443 |
| H3.15 | Issue 17: LACK OF SUPPLIER STANDARIZED WORKING METHODS and CMM/CMMI Practices PR61 to PR64 | | Strength of Association |
| H3.15.1 | PR61: Evaluates supplier technical solutions (designs) to confirm that contractual requirements continue to be met | Yes | 0.634 |
| H3.15.2 | PR62: Selects suppliers based on an evaluation of their ability to meet specified requirements and established criteria | Yes | 0.614 |
| H3.15.3 | PR63: Selects, monitors, and analyzes supplier processes | Yes | 0.658 |
| H3.15.4 | PR64: Selects suppliers using a formal evaluation | Yes | 0.707 |
| *P=.05/64 = 0.00078125 (Bonferroni's Adjustment) | | | |

| Company | Goal | Industrial CMM/CMMI Best Practices and maturity level |
|--|--|---|
| 1: US IT offshoring client companies that want to mitigate management problems when offshoring | Mitigate over expenditure due to hidden costs incurred by the client company | <ul style="list-style-type: none"> • A project plan is established and maintained as the basis for managing the project (CMMI ACQ, CMMI DEV, CMMI SVC, ML2). • Establish and maintain the overall project plan. (CMMI DEV, CMMI SVC, ML2). • Estimate the project’s effort and cost for work products and tasks based on estimation rationale (CMMI ACQ, CMMI DEV, CMMI SVC, ML2). • Establish and maintain the project’s budget and schedule, milestones, constraints, dependencies (CMMI ACQ, CMMI DEV, CMMI SVC, ML2) • Monitor supplier project progress and performance (effort, and cost) as defined in the contract (CMMI ACQ, CMMI DEV, CMMI SVC, ML2) • Manage invoices submitted by the supplier (CMMI ACQ, ML2). |

To explain the statistical results, a possible hypothetical scenario is developed based on the company background and the targeted goal. Adopting CMM/CMMI models and performing multiple CMM/CMMI practices may help in mitigating the IT offshoring issues (Table 10)

Table 10: A Hypothetical Scenario

5. Conclusions and Limitations

This research contributes to the existing body of knowledge on the offshoring of IT services from the client management perspective. The key findings can be summarized as:

Finding 1: US IT companies applying CMM/CMMI models have fewer issues associated with IT offshoring.

Finding 2: When US IT companies utilize and incorporate different practices from TSP and People-CMM into CMMI-DEV/SVC and CMMI-ACQ, they have fewer offshoring issues related to language barriers and cultural differences.

Finding 3: US IT companies applying 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.

Finding 4: US IT companies achieving higher maturity levels of CMMI have fewer issues associated with IT offshoring compared with lower maturity levels.

Finding 5: US IT companies routinely performing industry practices have fewer issues associated with IT offshoring.

While our research made contributions, it had limitations. This study was restricted to the US IT offshoring services companies. Conducting this study in another country would help to make the results more generalizable. This research focused on only four CMM/CMMI models tested. It would be interesting to expand the survey beyond the adopted CMM/CMMI models and expand to other quality standards models. Another limitation related to research design was that only a limited set of relationships (correlations) were tested. This research focused on companies that applied one of the four CMM/CMMI models and conducted additional analysis for companies that adopted multiple CMM/CMMI models that would (1) reduce the robustness of the claims one could make on the current analyses and (2) deviates from a pure application of the scientific method.

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