Critical Success Factors of the Offshore Outsourcing of Software Development Projects: A System Dynamics Approach[†]

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Abstract

This research focuses on the offshore outsourcing of software development projects. Little research has been conducted on the factors that would mitigate risks from the specific contexts of these projects. This study identifies and provides an understanding of the structural causes of issues that can occur and which impact offshore outsourcing projects performance. The main objective of this research is to propose a list of the most important critical success factors (CSFs) in the context of offshore outsourcing software development projects by providing a dynamic hypothesis based on the qualitative modeling principles of system dynamics. The analysis of data collected as part of this multi-case research study was used to systemically model the sequence of three software development projects outsourced to vendors in India by a large client located in North America. The study revealed six CSFs that promote the emergence of behaviors deemed desirable or limit the scope of events deemed undesirable, namely: the level of technical knowledge of the supplier, the availability of technical experts from the client, the level of detail sufficient and low volatility specifications; trust based on objectives, transparency of the vendor's internal processes, monitoring mechanisms for control and project deliverables.

Key words: System dynamics, offshore outsourcing, software development.

[†]Paper presented at the 31st International System Dynamics Conference, Cambridge, MA, USA, July 21-25, 2013.
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Introduction

North American firms have long used offshore outsourcing for manufacturing activities to reduce production costs, particularly in high-tech and electronics (Bardhan and Kroll, 2003). While offshore outsourcing traditionally impacted "blue collar" jobs, since the early 1990s, a second wave of offshore outsourcing is related to "white collar" jobs. In particular, the software industry was the first to transfer a significant number of jobs overseas.

Academic research has long focused on the concerns of senior executives and IT managers, looking primarily at long-term and large-scale offshore outsourcing projects (Ketler and Willems, 1999). The perspective of teams participating in a project overseas remains relatively unexplored in the literature. Software development is one of the most frequently outsourced activities (Ketler and Willems, 1999). It is therefore necessary to inquire about the particular challenges project teams face in the context of offshore outsourcing, such as: the lack of prior knowledge of the vendor, cultural differences between team members, and problems related to geographical distance (Gopal, 2002).

The literature suggests that the project management and software engineering "best practices" remain important to mitigate risks from the following issues: geographical distance, cultural differences, organizational and contractual relationships between project teams' clients and vendors. It is important to note the management of human relational aspects, in particular the ability to develop and maintain a trusting relationship with the project vendor (Sabherwal, 1999). Jennex and Adelakum (2003) cite the level of trust, the level of client knowledge, and general knowledge and skills of the vendor as critical success factors for this type of project. This list of critical success factors does not provide an explanation of the structure of interactions responsible for the dynamic behavior that takes place between a client and a vendor, nor does it explain why these factors on the list are "critical."

This research demonstrates how the principles of system dynamics can be used to study the critical success factors in software development projects outsourced overseas. The context of this empirical research builds on the experience of project teams in a multinational manufacturing company in the United States. In this context, knowledge and skills management, project management, and software engineering teams are considered critical to the success of outsourced projects.

This paper is organized into five sections. The next section explains the particular context in which the offshore outsourcing of software development projects took place, and summarizes results of the literature review. In section 2, question and research objectives,

arising from the lack of clarity about critical success factors suggested by the literature, is demonstrated. Section 3 presents the research method and explains choices made regarding the research steps, the business context, data collection and the analysis of results for the qualitative multi-case study, while Section 4 details the analysis of the dynamic hypothesis that led to the identification of systemic behaviors and present the results of this research. The paper concludes with a summary of the contributions and avenues for future research.

1. LITERATURE REVIEW

The Outsourcing Institute defines outsourcing as the strategic use of external resources to perform tasks traditionally assigned to internal resources. Outsourcing is known as "offshore outsourcing" (offshoring) when the outsourced activities of the organization are held on another continent. The outsourcing of IS is defined as the acquisition of various contractual system functions, including: data center management, operations, hardware support, software maintenance, networking, software development and even from external service providers (Kishore et al., 2003). Outsourcing contracts stipulate an obligation therefore results from the provider, rather than an obligation of means (Lacity et al., 1996).

The outsourcing may be a one-off contract or periodic and based on a long-term agreement. The scope, duration, and type of outsourcing arrangements can vary greatly from one organization to another (Gurbaxani, 1996). Many options for the acquisition of goods and services are offered today to managers eager to optimize the management of the IT function. Unlike outsourcing, which is the total transfer of the entire IT function to a vendor, the most common tactic is that of selective outsourcing (selective sourcing). It aims to identify activities or systems outsourcing candidates based on their operational and strategic contribution to the company, the maturity of the technology, internal management skills, as well as the size of the outsourced activity (Lacity et al., 1996).

Since the early 1990s, the research in the field of outsourcing has focused successively on a variety of themes (Lee et al., 2003), including: the motivation to outsource, the scope of outsourcing, the performance of outsourcing, outsourcing contracts, and outsourcing partnerships and relationships. Many firms outsource all IT activities through long-term contractual agreements. This type of outsourcing represents a relationship of complete dependence to a vendor, the primary objective of which is to reduce IT operation costs. The relationship is also governed by complex contracts by which organizations try to prevent an increase in long term costs. Thus, several studies have focused on long-term risks and benefits for organizations to adopt an outsourcing model (Ketler and Willems, 1999). By contrast, a number of risks were identified regarding IT outsourcing. Outsourcing can result

into a loss of control of the IT function, a loss of flexibility, an exodus of skilled resources, and ultimately into a loss of the competitive advantage. A risk factor is also the speed of adoption of the outsourcing strategy. The upfront organizational learning required to the success of the relationship becomes challenging if the adoption of outsourcing practices occurs too rapidly (Earl, 1996).

In light of the limited success of total outsourcing, there are concerns about the scope of outsourcing and there is a need to explore the characteristics and functions of outsourcing project candidates. It is called strategic acquisition services (strategic sourcing) or selective outsourcing (Lacity et al., 1996).

Research also has focused on the performance measures of outsourcing arrangements which attempt to assess the quality of outsourced services and client satisfaction. We note that organizations must use "easy" and objective measures to evaluate services received to avoid opportunistic behavior on the part of a vendor (Aubert and Rivard, 1997). Contracts are instruments serving legal formalization of agreements to apprehend a set of contingencies that may arise during the activity period (Cloutier and Gold, 2004). Contracts are therefore used to mitigate risks of outsourcing by formalizing legal outsourcing relationships. Given the prospect of long-term outsourcing, we wonder about the realism of preventing an increase in the cost of outsourcing over the years through contractual clauses. One approach is to negotiate the "spirit" of the agreement rather than a very specific set of clauses (Fortgang et al., 2003). It puts an emphasis on the development of a psychological contract which aims to clarify and mention explicitly the nature of the relationship, expectations, the duration of the agreement and conflict resolution mechanisms.

Developing partnerships with strategic vendors is a key determinant of the success of outsourcing initiatives. The study of the mechanisms and factors that influence the development of the outsourcing client-vendor relationship is becoming a major concern for researchers. The development of such a relationship and the reconciliation between the two organizations cannot be instantly established, but rather, it shapes over time. There are four types of outsourcing relationships defined in terms of the strategic importance and the scope of services in outsourced IS: relationship support, dependence, alignment and alliance (Kishore et al., 2003). The dynamic nature of the outsourcing relationship has important implications given the context. The expectations of an organization about outsourcing are subject to change. In addition, it can be assumed that the organizational learning capability is an important factor for the outsourcing activity to be successful (Lacity et al., 1996).

1.1 Characteristics of offshore outsourcing projects

The role of internal resources in project teams is little studied in the literature. The phenomenon of selective outsourcing overseas is quite recent. When outsourcing software development overseas, the client firm is responsible for drawing up the specifications it then gives to a vendor for the realization of the software. Once the software is developed, the firm generally chooses to deploy and implement the system. Many interactions are required between the client and the vendor who share responsibility for the project. This type of project has specific risks related to the interaction between the parties which must be properly managed by those responsible for internal projects (Davey and Allgood, 2002).

It should be noted that the prospect of internal resources in project teams is little studied in the literature. Given the geographic and organizational separation between the client and the vendor, the outsourcing relationship between two firms develops through contact persons, including project and client-side managers. Each party perceives the other through an interface or the exposed part of the technology, business processes, and the human resources of the firm (Adelakum and Jennex, 2003). As with any project, the client and the vendor should assign appropriate resources, and use appropriate control processes and mechanisms, and develop technologies needed for success. It can be assumed that of specific importance is the choice of contact persons to insure the success of the relationship.

1.2 Success factors of offshore outsourcing

Compared to the abundant of literature on the strategic aspects of outsourcing, little research has been conducted on the outsourcing of software development projects, despite the growing popularity of this practice. Indeed, the literature surveyed revealed only a few articles on success factors for software development projects. Jennex and Adelakum (2003) conclude that the confidence level of the client knowledge, and the general knowledge and skills of resource providers are the most important critical success factors. They also suggest that client firms need to focus on establishing a "good" outsourcing relationship, to ensure that they have as a person of contact "good" resources, and that a relationship based on trust may exist with contracts for fair and reasonable expectations about performance and appropriate communication channels.

Trust is a critical success factor because all risks associated with a project can never be completely eliminated. It is certain that problems and unexpected issues will occur and will need to be resolved. Excessive structural controls may affect project performance because significant resources could be assigned to measure and report progress rather than continue

on the primary task of software development. Trust reduces the need for structural controls in lowering the probability of occurrence of opportunistic behavior by the other party (Sabherwal, 1999). However, the relationship cannot rely exclusively on trust since the lack of structure and formality can also impact project performance. It is therefore important to strike the right balance between the use of trust and the use of formal control mechanisms throughout the project.

The second critical success factor identified by Jennex and Adelakum (2003) is the level of client knowledge. This refers to the level of understanding that the client person of contact needs of its user community and business area, and the level of understanding of the technology being developed. These two elements are seen as essential to communicate software specifications to the vendor. The authors themselves admit that the term "level of client knowledge" encompasses several aspects that deserve to be studied individually. For example, the availability of the client person of contact to share and clarify specifications with the vendor, and the methods and tools used to do so (Koh et al., 1999). The availability of the client is more a matter of perception. For example, the level of participation required by the client depends on the perception of the client and vendor regarding project risks. The client may have been available but has not considered important to invest in an activity that the vendor thinks is critical (Petkov and Petkova, 2003).

The third critical success factor, the level of knowledge and expertise, is controlled entirely by the vendor during the selection of resources it allocates to the project. This level of knowledge greatly influences the vendor's ability to understand client needs, to produce a system that meets these needs, and to create and communicate the resulting documentation (Jennex and Adelakum, 2003). The implication for the firm is that it should not select the vendor on a cost basis only, although the availability of cheap resources is often cited as the primary motivation for corporate clients to adopt offshore outsourcing. Presumably a firm can bid on a project with several vendors and has the flexibility to select a partner whose resources have the desired technical knowledge. Vendors, however, can be perceived as overly qualified because a large asymmetry in skills is a source of distrust for the client who could see a threat to its job or the possibility of opportunistic behavior on the part of the vendor (Gupta and Raval, 1999).

2. RESEARCH QUESTIONS AND OBJECTIVES

The literature is abundant on the decision and strategic aspects of outsourcing. It can be assumed that firms have the resources for an informed choice about the types of projects to

outsource, vendor selection, and can mitigate significant risks. However, questions about the realization of these projects, once the decision of outsourcing has been taken, remains unexplored. It is therefore appropriate to raise research questions about problems and challenges facing project teams assigned to internal offshore outsourcing of software development projects. The literature draws some attention to four critical success factors (CSFs) in the development of offshore outsourced systems:

CSF 1: The quality and low volatility of technical specifications (Gupta and Raval, 1999);

CSF 2: The level of knowledge by the client point of contact about user needs, availability, and engagement in supporting the project (Jennex and Adelakum, 2003; Gupta and Raval, 1999);

CSF 3: The development and maintenance of the level of trust between the client and the vendor, balanced by control mechanisms (Jennex and Adelakum, 2003; Sabherwal, 1999);

CSF 4: The general knowledge and technical competences of the vendor's resources involved in the project (Jennex and Adelakum, 2003; Raval, 1999).

Each of these CSFs possesses several dimensions for which their relative importance have not been evaluated or established in the literature. The CSFs have not been developed to a level of detail sufficient to enable the identification of key competences because they can be interpreted in several ways. The issue of CSFs deserves further study. Research has been conducted about broad aspects of CSFs in software development projects. But these factors have not been developed in sufficient detail. In addition, this list of CSFs does not examine the dynamics that takes place between the client and the vendor, or justify why they are "critical". For example, the literature has failed to understand the interrelationship between the elements involved, such as the contribution of the various CSFs on the development of trust.

The main research question addressed in this paper is: **How do CSFs impact the management dynamics of the offshore outsourcing of software development projects?**

The main objective of the research is to propose from the literature a list of the most important CSFs in the context of the offshore outsourcing of software development projects and to provide an assessment based on a multi-case empirical investigation of such projects. This will help IT managers identify the knowledge and competences to be developed within organizations to ensure the success of their outsourcing strategy, in general, and of their offshore outsourcing of software development projects, in particular.

3. RESEARCH METHODS

3.1 Research Context

The organization is one of the largest food manufacturing companies in the world, with operations in 75 countries. As for the entire organization, the IT function is split into two distinct entities: the North American segment and the International segment. To reduce its operating costs and redeploy internal resources to activities deemed critical to the success of business units, the North American IT function wishes to selectively outsource some of its activities including software development. The organization has outsourced 15 critical projects representing approximately 5% of the IT budget allocated to software development.

Among 15 offshore outsourcing software development projects conducted by the firm, this study examines three of these software development projects (Alpha, Omega, PI) with a budget over $ 100 000. Some indications about the projects examined in this paper are given in table 1.

Table 1. Offshore outsourcing projects selected for this study

Project	Description	Offshore outsourcing details
Alpha	Software version change for the corporate management of tenders and the procurement of raw materials, equipment and services required to upgrade parts of several software components	$225 K of a total budget of $830 K allocated to the conversion of the application and contents in India.
Omega	Version change and enhancements to the ERP system	$313 K of a total budget of $580 K allocated to the upgrading of the existing system to a more current version of SAP in India
PI	Development of a production middleware for the integration of three manufacturing systems	$118 K of a total budget of $515M allocated for the development of improvements in India

3.2 Research design

System dynamics (SD) can be used to study of the relationship between different constructs involved in the context of the offshore outsourcing of software development projects. The SD principles include group model building. It is important to note that the proposed

dynamic hypothesis in this paper is not the ultimate goal of the intervention, but rather a means by which it is possible to develop an understanding of the problem and reach a consensus on its description and definition (Vennix, 1996).

The key to SD modeling is to start and finish this process with an influence diagram (ID) (Coyle, 1998). The art of SD involves the discovery and representation of the structure of feedbacks loops to determine the dynamics of a system (Sterman, 2001). There are two types of feedback loops: Reinforcing loops, which tend to strengthen and amplify the behavior of the system, and balancing loops, which seek equilibrium and "oppose" the direction of change. A complex system can easily contain thousands of feedback loops of each type, which interact with multiple time delays, relationship nonlinearities and accumulations. The dynamics of all systems arises from the interaction of these feedback loops within systems (Sterman, 2001).

The use of SD was considered appropriate for this research because its main objective is to understand the structural causes of success or failure of the offshore outsourcing of software development projects, and to identify CSFs which could help an organization address issues associated with avoiding project failure. At this stage, the application of the qualitative principles of SD is required in this research given the objective is to develop a basic understanding of the problem of the offshore outsourcing of software development projects, and the limited time resources managers and other study participants could realistically allocate to this study, and the presence of constructs difficult to quantify (e.g., trust).

3.3 Research steps

The research method was based on two main steps. Step 1 - ***Preparation for data collection*** consisted in selecting participants and develop presentations and documents used for data collection. First, the participation of project managers (client contact person) was considered essential because these individuals have participated in all project activities and had many interactions with the vendor. Since the projects studied are part of long-term partnerships, the client was trying to develop with the vendor, the participation of IT function managers involved in these projects was considered essential. These individuals were, in fact, providing some additional information about their long-term goals and other factors that could influence the selection of the vendor. The directors of IT functions have led the three projects examined and have participated in this study.

A presentation on the issues of offshore outsourcing, the purpose of the research, and an overview of the SD principles was prepared for the preliminary interview process with IT

function managers which were carried at the next step. A semi-structured questionnaire was developed to capture initial impressions and perceptions of the participants regarding the problem of the offshore outsourcing of software development projects. The questionnaire was not distributed to the participants, but rather guided the interview process and was used to organize responses and comments from participants.

Step 2 - ***The data collection method*** was carried out following the guidelines suggested by Luna-Reyes (2003) for SD modeling. The data collection process began with phone interviews with each individual participant identified in the previous step. The purpose of this initial contact was to gather information about the context of the offshore outsourcing of software development projects, their progress and outcomes. Given the amount of information transmitted through these interviews, they were recorded electronically to obtain an accurate account. The prior development of an initial influence diagram (ID) by the moderator had the advantage of reducing significantly the time required for group modeling and facilitated the understanding of the basic SD modeling principles by individuals not initially familiar with them (Vennix, 1996). To adequately document the offshore outsourcing problem, the ID was initially developed by targeting topics related to the four initial CSFs identified for this study.

However, by examining the interview data, it was observed that some of the sub-constructs had not manifested in the projects examined, or that their definitions differ somewhat from the ones introduced in the literature. The reference themes established for the elaboration of the ID were:

- The functional complexity, the importance of quality specifications and their transfer to the vendor;
- The technical complexity of the project and the need for the vendor to provide competent resources and technical experts to the client;
- The quality of the vendor-client relationship influenced by the alignment of objectives between the parties, and the quality of the project's control mechanisms.

These three themes, although related to CSFs identified in the literature, are somewhat different. The initial dynamic hypothesis represented in the ID was defined using a variable dictionary following an examination of interview reports.

The initial dynamic hypothesis, represented by the ID, was then used during an evaluation group session for each project. The information collected after each session was used to adjust the initial ID in preparation for the next session.

4. FORMULATION OF THE DYNAMIC HYPOTHESIS

4.1 Initial interview result analyses

Table 2 presents the CSFs identified in the literature, and the presence of these in the projects studied. These results come from the analysis of interview data and answers by participants to questions related to CSFs.

Table 2. Presence of CSFs in projects

No	Critical Success Factor / Dimension	Alpha	Omega	PI
CSF 1	Quality and low volatility of specification:	No	Yes	Yes
	- Level of detail in specification document		X	X
	- Degree of formalism employed in the document			
	- Medium used by the transmitter to communicate specification, Interpretation and understanding of the information by the receiver		X	X
	- Specification volatility			
CSF 2	Level of knowledge of client contact person regarding users' needs, availability, engagement in project support:	Yes	Yes	Yes
	- knowledge of business sector			
	- Availability		X	X
	- Sufficient knowledge of technology used	X	X	X
	- Knowledge of software engineering process and standards			
	- Alignment between vendor and client		X	X
CSF 3	Trust development and sustainability between the client and the vendor balanced by proper control mechanisms:	Yes	Yes	Yes
	- Calculated trust		X	
	- Trust based on knowledge	X	X	
	- Trust based on objectives	X	X	
	- Trust based on performance	X	X	X
	- Appropriate development methods and trust sustainability			
	- Balance between trust and control		X	
	- Appropriate contractual clauses to determine the control	X	X	
CSF 4	General knowledge and technical competences of vendors' resources allocated to projects:	Yes	Yes	Yes
	- General knowledge of business sectors			
	- Technical competences	X	X	X
	- Symmetry of technical process between the vendor and the client			

4.2 Elaboration of the initial dynamic hypothesis

4.2.1 Identification of themes

Not all CSFs identified in the literature seem relevant in the execution of projects. Based on interview data, some project aspects seem to have had a significant influence on their success or failure. The CSFs were divided into three themes to reflect the reality of the projects studied. The correspondence between these themes and the CSFs is shown in figure 1, as follows: Theme I: functional complexity, the importance of quality specifications and their transfer to the vendor, Theme II: technical complexity of the project and the need for both relevant vendor resources and client technical experts, and Theme III: the quality of the relationship, influenced by the alignment of objectives between the parties, and project quality control mechanisms.

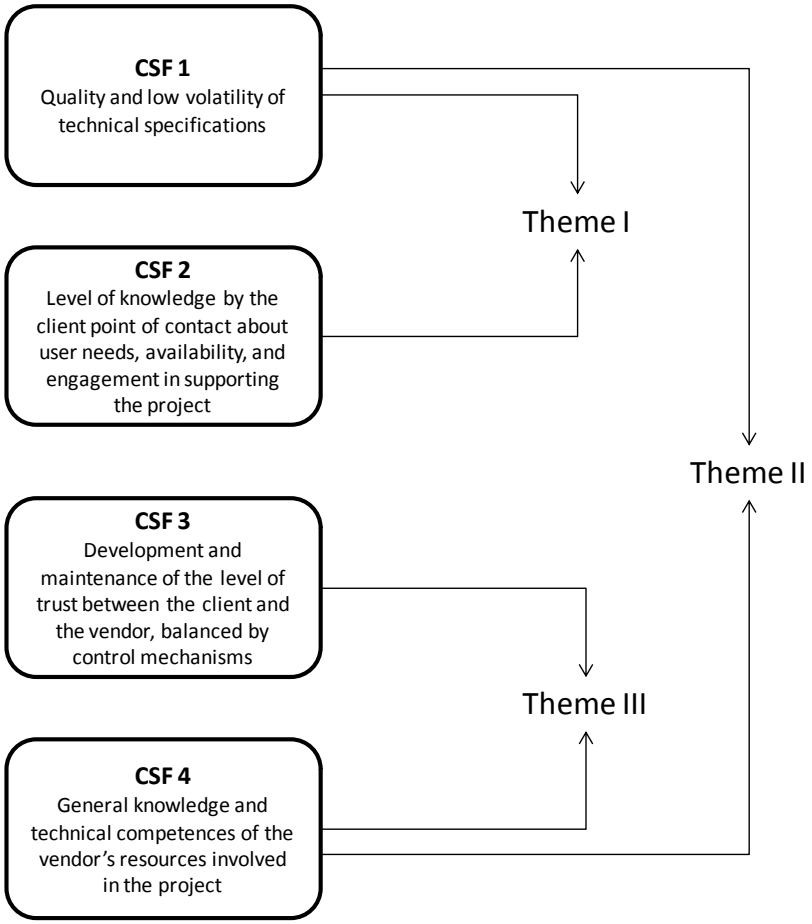
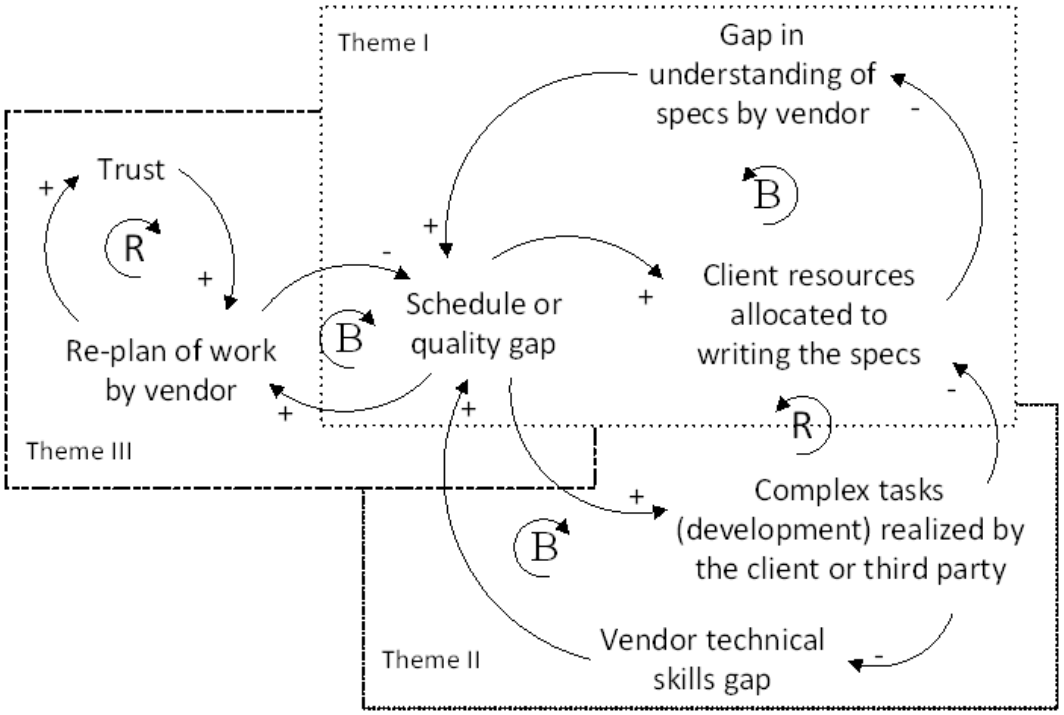


Figure 1. Comparison between CSFs and specified themes

4.2.2 Level 1 ID and relationships between themes

The modeling process is iterative and begins with a Level 1 ID which presents a summary view of the interrelationships between the themes.

At a high level, figure 2 shows the set of actions aimed at reducing deviations from the deliverables schedule and quality. The cause of these deviations may be due to a misunderstanding by the vendor of the work to be performed (Theme I), or to a lack of technical knowledge required to carry out the activities specified (Theme II). The initial response to a gap in the timeline is to try to meet the contractual agreement, and therefore the vendor tries to reschedule the work to fulfill its obligations (Theme III).



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4.2.3 Theme 1: Functional complexity / Quality and specification transfers

The theme I describes the resource allocation problem to client specification and their transfer to the vendor. In the projects studied, where the development of new features is less important relative to the conversion of existing systems, the scope of the work to be done changes little during the project and specifications remain relatively static.

The evidence from the interviews are rather related to the effort required to develop specifications (including test procedures and acceptance), and the communication of these specifications to the vendor who has little field and business process knowledge of the client firm. The notion of specification refers not only the description of new features to be developed, but also to the functioning of the existing software, the relationship between the different modules of the system and how the system is configured and used by users.

This theme is thus closely linked to the availability of client resources to develop the enormous amount of documentation required for a complex system, as well as their availability to answer questions and repeating explanations until the vendor has understood the job. Since the repeated communication of specification requires greater interaction between members of the client team with their counterparts from the vendor, cultural differences related to communication have an influence here, as well as knowledge-based trust amongst participants.

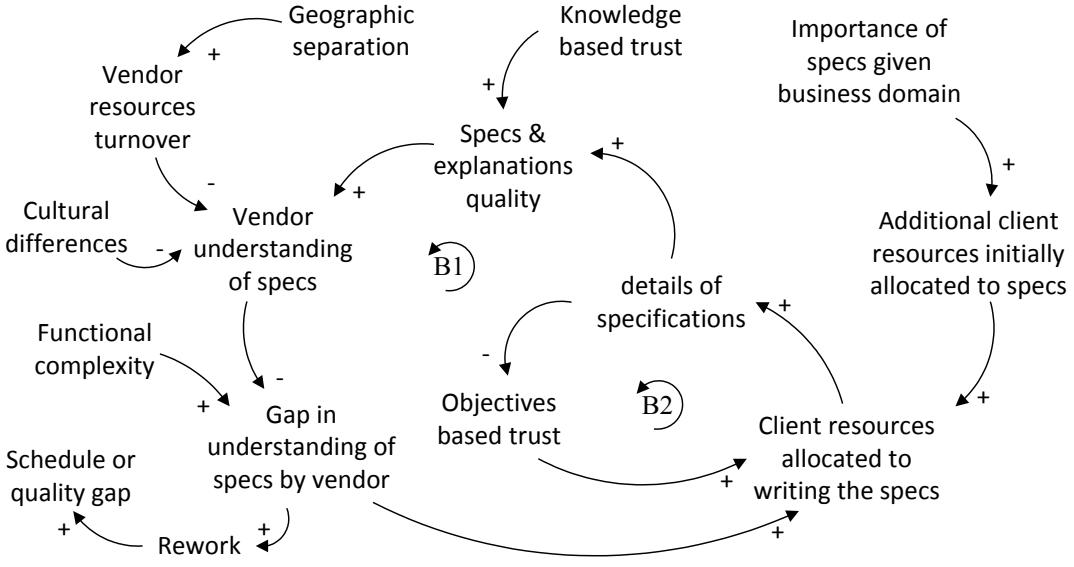

Figure 3. Theme I: Functional complexity / Quality and specification transfers

The ID in figure 3 shows that the balancing loop B1 where individuals responsible for writing specifications are also the ones who check the quality of the software once delivered by the vendor. The learning curve of the vendor, here named the gap in understanding of specs by vendor, is proportional to the functional complexity of the system that is the object of the work on the project. Over this gap, the greater the Client resources allocated to writing specs will be. The number of resources depends on the number of Additional client resources initially allocated to the development of specs and can itself vary according to industry practices and client.

The greater the amount of client resources allocated to writing the specs, the more it translates into greater details of specifications. The feedback loop B2 shows that there is a limit to the level of realistic details that can be specified. At one extreme, pseudo-code could be provided to the vendor, but, it is more appropriate to use another vendor to do the work. This would become a mere translation of the pseudo-code into a software product. It is for this reason that the increase in the level of detail specifications lowers objectives based on trust because the partnership becomes less profitable for the client. This loss of confidence based on trust-based objectives results in a propensity for the client to allocate fewer resources into the drafting of more detailed specifications.

The volume of detailed specifications does help to increase the quality of specifications and explanations given by the client to the vendor. Explanations actually depend on the availability of resources allocated to the development of specification efforts, but also to the level of trust based on knowledge between client and vendor resources. Participants noted that the process of explaining the specifications to the vendor was very frustrating because they had to constantly repeat the same explanations. Participants also mentioned that Indian vendors did not like to ask questions or to show that they did not understand what they were being asked to do. Thus, trust based on knowledge eases the communication because the vendor is more comfortable to ask questions and client resources have more patience to answer questions when they developed some familiarity with the vendor.

Quality specifications and explanations increase the level of understanding of specs by the vendor. Cultural differences can impede the process of knowledge acquisition by the vendor to the extent that a poor command of the language can become an obstacle, or because the vendor does not ask questions.

The frequent rotation of the vendor contact person is a barrier to understanding the specs by the vendor as previously acquired knowledge about the project is lost. On the Alpha project, this turnover was attributed to geographical separation because a contractor

working on site had problems in obtaining work visas for members of the vendor's team to work on the client's premises.

The balancing feedback loop B1 closes by reducing the gap in understanding of specs by the vendor as the understanding of the specs by the vendor increases.

To conclude the description of Theme I, it must be noted that the gap in understanding of the specs by the vendor occurs during acceptance testing performed by the client upon receipt of deliverables. It is for this reason that the gap in understanding is described as increasing the rework by the vendor that translates into a time delay or quality gap. On this last point, a participant in the Omega project considers that one can only minimize the time delay differences related to the quality or specifications without ever being able to eliminate them completely. To accomplish this, one would need to be writing specifications at a level of detail that is unrealistic in the context of such a project.

4.2.4 Theme II: Technical complexity/ Technical knowledge of the global team

The literature highlighted that one of the CSFs was the reported level of technical knowledge of the vendor. From the interviews, what has become clear is that the overall level of technical knowledge available for the project, whether from the client or the vendor, plays a key role. This factor, that is, the role played by the client's technical experts in the project has been ignored in the initial formulation of the dynamic hypothesis.

The level of technical knowledge of the vendor is a necessary condition, but it does not appear to be a sufficient one to insure the success of the project. Within the context of this study, the technical complexity was not limited to the control of the programming language, but also included the integration of the system into a much broader and complex environment. In project Alpha, for example, the complexity of the conversion was increased, given the changing technology platform, in addition to the conversion of interfaces developed specifically for the firm with other systems. In such situations, it is unlikely that the vendor's resources master all technologies used in the project. The client participation as an expert becomes important.

In figure 4, the balancing feedback loop B5 illustrates the normal learning process that the vendor must follow to develop the necessary technical knowledge to conduct the project. Although the vendor may have a good technical knowledge base, or even specific knowledge of the programming language required for the development of the system, there

will always be a knowledge gap that must be bridged, linked to the specific way the technology is used by the client.

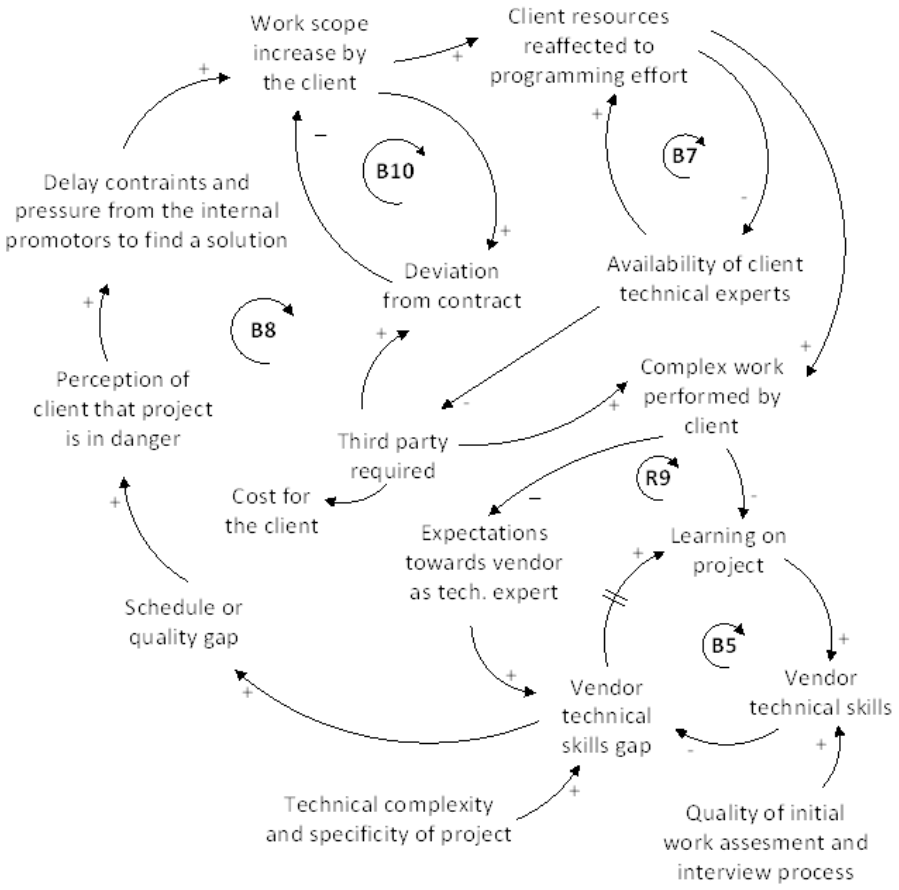

Figure 4. Theme II: Technical complexity/ Technical knowledge of the global team

The level of expertise of the supplier depends on the initial selection of individuals by the project vendor. A project participant mentioned that the Omega interview process had contributed greatly to select a project manager who had performed successfully and had deep required technical knowledge for the project. The same participant added that if the occasion were to arise, they would interview all of the vendors' team members and insist for the presence of one or two other individuals that have very specific knowledge about Omega. It is for this reason that the quality of the request for proposal, evaluation, and interviews increases the level of technical knowledge of the vendor from the beginning of the project. As the level of specific technical knowledge by the vendor grows, the gap in technical knowledge required decreases. The technical knowledge gap is proportional to the complexity and technical specificity of the project. Technical specificity is important

because it emphasizes that it is more difficult to assemble a team with a high level of technical knowledge when it comes to an uncommon technology, as was the case for project Alpha

The initial gap forces the vendor to learn about the project (on site) and aims to increase its level of technical knowledge on specific aspects of the client's system.

The balancing feedback loop B8 shows actions initiated by the client when delays are caused by a lack of technical knowledge and cannot be minimized by the vendor. Indeed, as the knowledge gap persists on the technical front, it prevents the vendor from fulfilling its responsibilities, and project schedule or quality gaps occur. These delays increase the client's perception that the project is in jeopardy and can decide to intervene to remedy the situation and to ensure its success. In particular, depending on timing constraints and internal pressures by promoters to find a solution, the client may decide to increase its own scope of work beyond the contractual arrangement to lend a hand to the vendor. This is what happens in the case of the Omega project where the project manager said the responsibility for the conversion of some of the very complex modules were conducted by the client.

It must be emphasized here that the increase in the project scope by the client is attenuated by the contractual agreement. Indeed, the more the client takes under its responsibility for activities that increase its workload and costs, the greater the deviation from initial contractual terms between the parties. Therefore, the client should not undertake too many activities because the vendor must be paid, whether the latter does that work or not.

The reallocation of client resources to code development effort depends on the availability of the client's technical experts. In the case of the Omega project, the client had internal resources able to assist the vendor, as one member was added to the team from a U.S. supplier specializing in Omega.

In the case of the project Alpha, the manager faced the same problem but had no internal resources with the required knowledge. It is for this reason that a third party was used, namely the Alpha Company, to add to the team members with the required technical knowledge. The use of a third party has a 'cost to the client' impact on the project.

As the more complex work is completed by the client, or by a third party, the more expectations of the vendor as a technical expert decrease. The balancing feedback loop B8

loses to show that the client is less dependent on the vendor for the accomplishment of complex tasks, which has the effect of reducing the gap in the vendor's technical skills.

The reinforcing feedback loop R9 complements the balancing loop B8, only to stress that as the complex work conducted by the client, or third party increases, the vendor loses the opportunity to develop knowledge by performing complex tasks. This perpetuates the problem of the technical knowledge gap for the vendor.

4.2.5 Theme III. Relationship quality / Long term perspective, objective-based trust and control mechanisms

The third theme introduced in figure 4 focuses on the quality of the relationship, but this is not limited to the context of the project. It must be considered that trust based on objectives goes beyond the project, and focuses more on the relationship in the longer term that the client and the vendor are trying to develop.

So far, a description has been given of the actions taken by the client in response to delays caused by a lack of technical knowledge or misunderstanding of the specifications by the vendor. But, balancing feedback loops B6, B20, B15, and B21 are about actions taken by the vendor to address a schedule or quality gap. It is difficult to evaluate appropriately these loops as they are intentions and perceptions about the vendor, which clients, as participants in this study, can only assume.

The feedback loop B6 shows that the initial reaction of the vendor is to begin an internal re-planning of work in response to a schedule or quality gap. This is what happened initially on the project Alpha as the project manager for the vendor offered to the client, at a few occasions, a recovery plan detailing actions to correct the situation, including overtime work for the vendor's resources.

The balancing feedback loop B20 shows that the acceptance by the client of the internal re-planning by the vendor is supported by performance-based trust. Indeed, in the project Alpha, the client found the vendor's contact person pleasant and professional and had no reason to doubt the good faith of the vendor. The client accepts several times the re-planning of the vendor, but the trust based on performance towards the vendor decreases as credibility is lost given the recovery plan that does work.

The vendor internal re-planning results in an additional allocation of vendor resources assigned to the project. This increases the workload of individuals or increases the size of the team. This additional allocation of resources by the vendor is constrained by the

availability of the vendor's own resources or by the reduced profit for the vendor whenever additional paid resources are allocated. The decrease in profit diminishes the trust based objectives, that is to say, the value of partnership for the vendor.

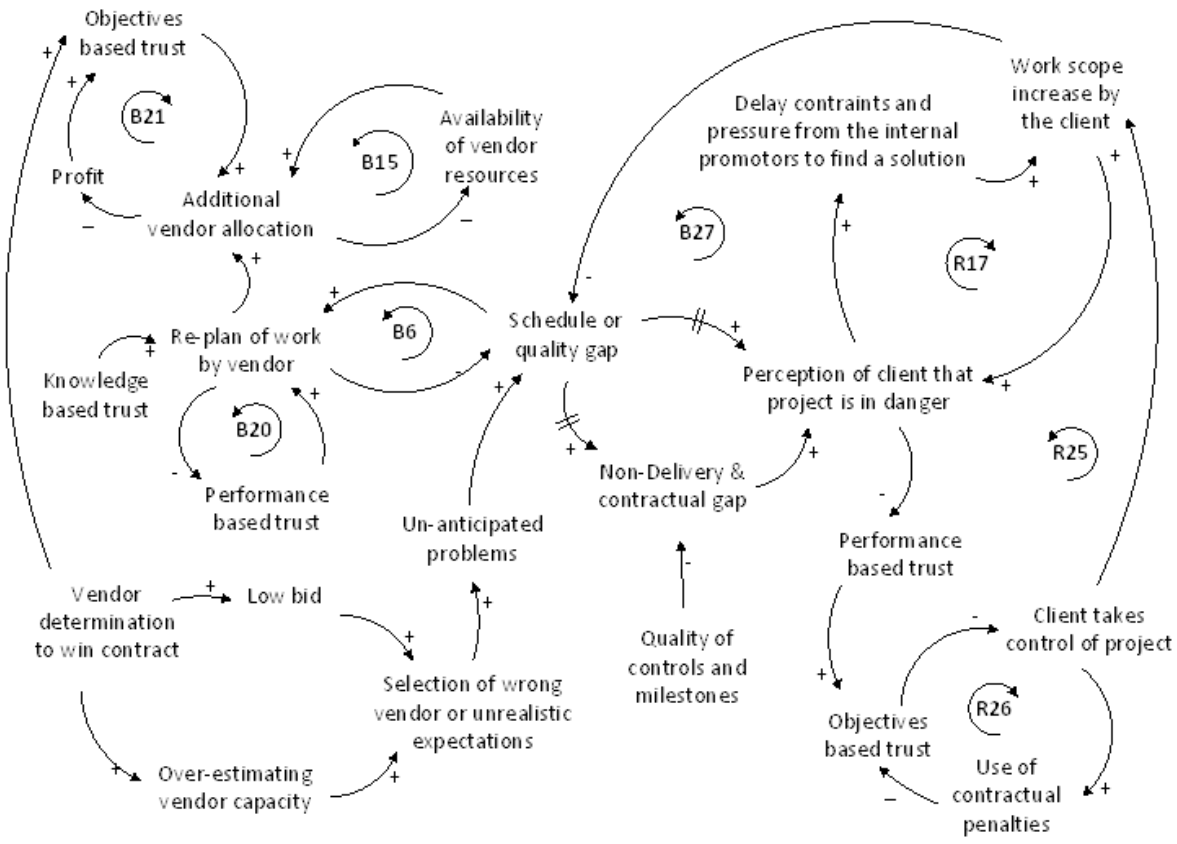

Figure 1. Theme III: Relationship quality / Long term perspective, objective-based trust and control mechanisms

For example, in the Omega project, certain characteristics and constraints were present that could have endangered the project: the schedule was tight and the vendor had underestimated the work to be done. This resulted in additional workload that was absorbed by the vendor. The influence of trust based objectives on the additional vendor allocation is very important. Regarding the Omega project, the manager reported that he had the impression that the vendor was willing to lose money to become the client's partner in future Omega projects. This vendor's willingness to win future contracts and develop a long-term partnership is demonstrated by the allocation of resources who worked seven days a week throughout the duration of the project to avoid schedule slippage.

The balancing feedback loop B27 describes the situation where the actions taken by the vendor cannot reduce the schedule or quality gap. These differences may accumulate to the point where the vendor fails to deliver under the contract, referred to here as non-delivery - standard contract. This was the case in the Alpha project where the vendor had not delivered the first 'milestone' stipulated in the contract, which was set up the test environment "sandbox". This contributes greatly to the client's perception that the project is in jeopardy. Performance based trust the client holds for the vendor decreases as well as objective based trust. The client perceives that the vendor is no longer a good partner for the project or for a long term commitment. Since there has been a non-delivery based on standard contract, the client may cancel the contract or change it without having to deal on equal terms with the supplier.

In the case of the project Alpha, there was a change regarding the control of the project by the client. The client redefined the scope of its responsibilities by taking over the coordination of the entire project. As described in Theme II, the Alpha firm was contracted as a third party entity to complete the work initiated by the vendor. The reinforcing feedback loop R26 shows that to compensate for this increased 'cost to the client', it used contractual penalties and decided not to pay the vendor. This action further undermined the objective based trust as both parties are now involved in a legal dispute.

It is interesting to note that the project client Alpha keep a good opinion about the resource vendor on the project, despite the breach of contract and project failure. This trust based on knowledge despite poor results on the project, however, shows that good agreement between the participants is not a sufficient condition for success. It is also necessary to emphasize the influence of the quality of controls and milestones on the non-delivery - and standard contract. By contrast, the Omega project was closely monitored for deliverables and all responded quickly to any offset from the work plan. In the case of the project Alpha, the deliverables were too far apart and the sustainability of the project was never in doubt. One could therefore suppose that the proper monitoring of the project by the client could minimize the event of non-delivery, and in turn promote actions to reduce the schedule or quality gap other than a breach of contract.

4.3. Analyses of results

Following the analysis of the dynamic hypothesis presented in the context of the multi-case research analysis, conducted using the principles of SD, the CSFs identified are the ones that seem to favor a set of desired system behaviors. The candidate CSFs identified in the literature review and the ones uncovered in the analysis of the themes can be used to

answer the research questions: How do CSFs impact the dynamics of the offshore outsourcing management of software development projects?

CSF 1. Technical knowledge level of the vendor

The general knowledge of the business sector has not greatly influenced the outcome of the projects studied. But, rather, the technical skills of the vendor emerge as the most important element influencing the course of projects Alpha and Omega. Indeed, the level of technical knowledge of the vendor has been identified as the fundamental problem that has been the source of delays on projects Alpha and Omega, and these delays in turn triggered the manifestation of system behavior issues.

CSF 2. Availability of technical experts on the client team

This very important CSF was not included in the initial list of CSF identified from the literature review. The analysis of the dynamic hypothesis has indeed revealed that the availability of technical experts at the client gave it the flexibility to cover for the legitimate vendor's technical knowledge gaps. The availability of experts has allowed the objectives of projects PI and Omega to reach a positive outcome.

CSF 3. Sufficient detail and low volatility of specifications

The quality and low volatility of specifications have been identified as a CSF, but the study brought some clarification on this item. The analysis of Theme II has revealed that the aim should be to develop specifications that include a sufficient level of detail, and not an extreme level of detail.

CSF 4. Objectives based trust

The study has revealed the relationship between trust based on performance and trust based on objectives. Indeed, trust based on performance appears to be related to specific tasks of the project and results in increased trust based on objectives, but it has a significance that goes beyond a given project. Trust based on the objectives relates to the long-term goal of developing partnerships between the parties, and not the specific short-term objective of the one-and-only project as one might infer.

For this reason, the development of objectives based trust seems to occur before the start of the project through partnership agreements with a vendor or during the call for proposal process. Trust based on the objectives has been identified as a critical success factor

because it promotes an increase in the scope of work by the client or the additional allocation of resources by the vendor that may be required during the project. In addition, the study did not reveal that the means were undertaken during the project to specifically increase the level of confidence based on knowledge (team building), and it does not appear that this type of trust has a major impact on projects.

CSF 5. Transparency of internal processes of the vendor

A second factor that had not been identified in the literature is the transparency of internal processes of the vendor. Indeed, when the vendor's operations are seen as a 'black box' by the client, the latter cannot develop a good understanding of financial or technical risks that threaten the project. In these cases, the client cannot make an informed judgment on the vendor's ability to develop solutions to solve fundamental problems occurring during the project. Transparency of the vendor's process is considered critical because it tends to minimize the possibility of 'shifting the burden' behavior and would rather promote the implementation of fundamental solutions.

CSF 6. Monitoring mechanisms for projects and deliverables

It does not appear that the controls have been used by the client to guard against opportunistic behavior by the vendor. However, the importance of mechanisms to monitor project progress and deliverables to help contact persons develop a better understanding of issues or elements which hinder the smooth running of the project. Thus, it is the monitoring mechanisms of the project and deliverables that are selected as a CSF since they promote a shared understanding between the parties regarding the causes of problems on the project.

Finally, the study has revealed that the level of knowledge of contact persons about the needs of users is reflected in the quality of the specifications, and this aspect has not been identified as a separate CSF. It also appears that the availability of the client and its commitment to support the project, are manifestations of the trust based on the objectives, and has not been identified as CSF in this study.

The CSFs proposed in this study are more accurate and nuanced than those initially reported in the literature. An explanation was given as to how these factors were involved in the manifestation of systemic behavior, and to show the interaction between them, within the context of the offshore outsourcing of software development projects.

5. CONCLUSION

The main objective of this research was to propose a list of the most important factors in the context of the offshore outsourcing of software development projects. This study aimed to understand the behavioral motivations that support or limit the positive outcome of the offshore outsourcing of software development projects, and then propose a list of CSFs for areas of knowledge considered the most important for clients to develop. To achieve this objective, a dynamic hypothesis that describes the microstructure responsible for the macrobehavior of the dynamic system in the conduct of offshore outsourcing projects has been developed. A qualitative modeling approach was used to structure the hypothesis using data collected on three offshore outsourcing software development projects conducted by a major North American firm.

The research question about the critical success factors was answered by analyzing the relationships between the variables of the IDs. The six CSFs are identified as variables in the dynamic hypothesis proposed that encourage the emergence of desirable systemic behavior. In addition, by confirming and clarifying the CSFs identified in the literature, this study provides a better understanding of the structural causes of potential issues that client project teams that develop software offshore may face. The development of a dynamic hypothesis contributes to the advancement of research as the literature review showed that a systemic approach was applied to the study of the outsourcing decision for a client firm (McCray and Clark , 1999), but not in the context of software development projects. Specifically, the study contributes to the understanding of how the CSFs are involved in the conduct of outsourced projects. This understanding of the "how" and of the "why" went beyond the creation of a simple list of critical factors, and has contributed to establish a firm understanding of the types of knowledge that should be developed within clients firms.

From an applied standpoint, the description of systemic behavior obtained in this study could help managers of offshore outsourcing of software development projects develop a better understanding of the root causes of the problems encountered during the course of their projects, and also enable them to assess the scope and consequence of actions they would take to correct these problems. Finally, the study is limited to a qualitative model according to Coyle (1998). Future studies would lead to the development of a level-rate model, which would contribute to better understand the systemic behavior of outsourced projects.

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