A System Dynamics Perspective into Offshore Software Outsourcing – uncovering Correlations between Critical Success Factors

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Abstract. Software offshore outsourcing is stirred among others by efficiency, availability of manpower, quality and cost reduction. The results are often disappointing and problematic to the offshoring company especially when the costs outgrow the desired budget or when the delivered software indeed turns out to be faulty. The anticipated possible complications in an offshoring project need to be vigilantly weighed and roughly approximated using tools that can generally predict the results of an offshoring project. This article presents a system dynamic approach to unearth the inherent risk of offshore software development. It consequently defines eleven highly interconnected elements with high levels of abstraction that can be used to generally predict the results. It additionally shows that these elements are inadequate and goes ahead to introduce some sub elements. A further study based on the sub elements is recommended.

Keywords: Software offshoring, software outsourcing, system dynamics, critical success factors

1. Introduction

A business is using the so called offshore software outsourcing in developing its software when it wholly or partially contracts out some of the software development activities to another. We speak about offshore software outsourcing – or shortly offshoring, if the organisation is remotely located. The "global software development", also "global software work" or "distributed software development", implies that the development activities are located in various parts of the World. The reasonable and successful execution of such a project is uncertain because of the diverse distribution of its activities all over the world. This offshoring may economically be seen as a natural evolution steered by lack of resources, shortened development cycles, tight budgets, higher flexibility and concentration in the core business, access to the qualified professionals and competition that create a need for cooperation with external partners. This offshoring phenomenon is a relatively new trend. It became a viable strategy in the 1990’s owing to Internet that enabled cheap and efficient transport of digital information to qualified workers in low cost countries. In the meantime, offshore software outsourcing remains a controversial subject. Benefits such as reduction of development costs, access to highly specialized professionals, flexibility, and reduced development time are some positive aspects. Nonetheless, the software offshore outsourcing is coupled with a couple of setbacks that compromise the results.

Communication among offshore outsourcing software developers is reported to be much more complicated than projects that are executed traditionally. Cultural differences often result to miscommunication. Moreover both geographic and temporal distribution negatively impact on the interaction between onshore and offshore teams. Various studies suggest that approximately 40 percent of offshore projects fail to deliver the expected benefits. Obviously, such projects are challenging and risky. The huge gap between the expectations and actualisation is for example caused by deficiency in theoretical basics in software engineering and lack of options as well as ignorance of the risks that are part of such an outsourcing software development project.

However, the offshore software outsourcing is a phenomenon that has become a key software development method in multiple companies. Obviously, the alluring benefits overweigh the inherent risks when deciding if a software development project is executed offshore or not. In respect to these inherent risks, the software offshore outsourcing does not make an exception to traditional software development. According to Boehm [1], most failures in software development projects would have been avoided had there been explicit early concern in identifying and resolving their high-risk elements.

In the current literature, multiple success factors and risks are linked with the software offshore outsourcing. The identification and management of the inherent risk requires the understanding of its causes. However, it is hard to name any single risk element that solely leads to the failure of an offshore software development project because the simultaneous interrelation of multiple elements often seems to cause failure. These interrelations are difficult to understand and their effects are hard to gauge. We propose a system dynamical approach to uncover correlations between critical success factors of outsource software offshoring projects. This approach provides a foundation for a tool that will be used for computer based simulation of offshore software outsourcing projects.

2. Risk Analysis of Offshoring

The first systematic representation of the “risk” in the software area was published in the Boehm’s spiral model in the 80's. This model is iterative and the risk analysis is done systematically. The word "risk" comes from the Italian word "risicare" that is derived from the Latin word “risicu, riscu” which means “to dare” [3]. Consequently, the risk is something that needs to be managed.

The risk may broadly be looked at from two perspectives: the economic and the managerial [8]. The economic perspective portrays risk as the variance of the probability distribution of possible gains and losses associated with a particular alternative. The managerial perspective portrays the risk as a danger or hazard to the potential positive realisation of a project since risk is associated with its negative outcome.

In the last decade the software development has grown to be even more risky. Success and evasion or minimisation of the risk through suitable methods of risk management is crucial. Risk management in software engineering focuses on all processes in the software lifecycle. Risk management should not only point out simple details in the project, but also be the core of the business [2]. Risk management may also help immensely in actively in preventing these problems.

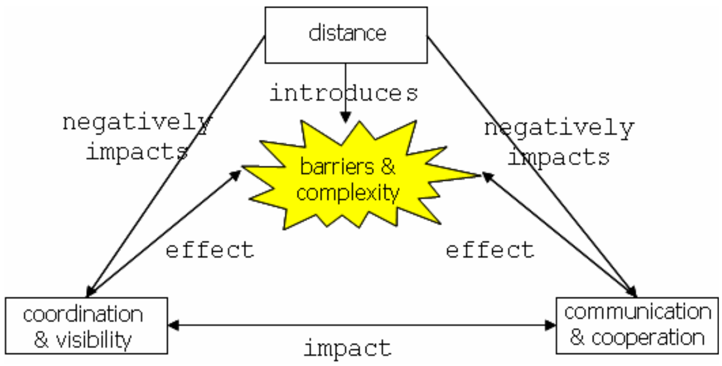

Figure 1: Impacts of the distance in a distributed environment (ref. [4])

The success of an offshore project can be gauged by three parameters based on the satisfaction of the client: quality, time, and costs. Quality is measured some what as the degree of the fulfilment of the requirements and as per the software design conformity. The time parameter simply refers to the deadlines. The third parameter, costs, refers to the fitting of the offshoring project into a desired budget. An offshore project that fulfils the expectations of the client is successful otherwise a failure. Approximately 40 % of offshore projects fail. One of the major reasons for the failures is distance.

The coordination and management of various tasks and decisions requires communication among the stakeholders Casey and Richardson state that distance introduces barriers and makes the management of these tasks even more complex. The key variables for success (effective coordination, visibility, communication and cooperation [6], [7]) are negatively impacted by distance. This is illustrated in Figure 1. Consequently, the major challenge in the coordination and management of offshoring projects is the minimization of these negative effects. Minimization however requires a more detailed insight into the causes and effects of the undesirable outcome, especially into the correlations between single success factors.

2.1 Undesirable Outcomes of Offshoring

Interviews were carried out so as to assist in the understanding of the components of risk and their correlations. Additionally, the results of the study were proven by means of a literature study. The possible high risk areas are illustrated in Figure 2. Technical aspects, IT-infrastructure or time zones have interestingly, not been found critical compared to soft factors like communication, the way of thinking, cultural differences, or project management. We are convinced that undesirable outcome mostly originates from by these four factors.

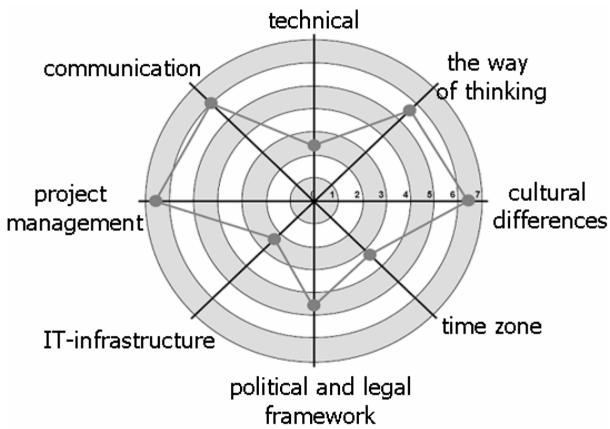

Figure 2: Problematic fields in offshoring (ref [22])

These factors are however structurally very abstract. The authors feel that they need to be split in sub elements so as to improve the critical fields. The sub elements and their impact need to be keenly analysed. Offshoring evaluation methods are handled in the following sections.

2.2 Evaluation of Software Offshore Development Projects

The success of an offshoring projects may be gauged against its major target i.e. cost reduction as to in-house development [10]. The expected cost reduction is heavily dependent on multiple co-relating factors. This makes it hard to unanimously predict their combined effect on the total cost. Multiple methods are indeed used to evaluate the economic benefits of an investment project. This section discusses the concepts of Return on Investment (ROI) and Balanced Scorecard (BSC) in respect to their capability to evaluate offshoring projects.

2.2.1 Return on Investment

ROI is a financial tool for gauging the economic return of a project or an investment. It is used to measure the effectiveness of the investment by calculating the number of times the net benefits (benefits minus costs) are recovered from original investment. It may additionally be used as a decision support tool. ROI is one of the most popular metrics used to understand, evaluate, and compare the value of different investment options. The ROI in an offshoring project is calculated according to the following equation: $\sum S - C_s - C_t$, with variables [11]:

- S savings per individual production step;
- C_s set up costs of the offshoring;
- C_t transaction costs of the offshoring.

The calculation of the ROI for offshoring is similar to the regular ROI calculation, except that when used for the offshoring calculation, it considers the savings instead of profit going away from the regular ROI investment calculations.

The major weakness in the use of the ROI in offshoring calculations stems from the fact that the determination of the reference costs is inaccurate in complex software development projects due to a likely change of requirements.

2.2.2 Balanced Scorecard

The balanced scorecard (BSC) was developed by Kaplan und Norten [12] in order to provide managers with a concept to measure the activities of a company in terms of its vision and strategies by giving them a complete over-view of the business performance. The focus contains financial outcomes as well as the human issues that drive those outcomes enabling an insight into the business using four perspectives: customer, internal, innovation and learning.

As mentioned above, BSC assesses the activities of a company. These four perspectives (service provider, software development project, outsourcing company and financial) have to be set suitably so as to accurately estimate the activities in offshore software development projects and eventually enable the use of BSC in offshoring projects. However, the use of these methods to assess offshoring activities may be criticized mainly because they does not consider critical success factors [14] like political and juridical stability in the vendor country. Another weakness is pointed out by Gold quoting *"… although the balanced scorecard is a useful and mercifully brief (one- or two page) reporting mechanism, it may not be the most effective vendor perform tool within the context of a legal contract or even a specific application. This is because the overall performance "score" is balanced among the four quadrants."* [15, p. 176].

Further more, the BSC only provides an ex-post insight into offshoring without including interdependencies between critical success factors. BSC too doesn't provide forecasting or simulation of offshoring. It hence seems to be unsuited for use as a priori risk evaluation method in offshoring projects.

2.2.3 System Dynamics

The characteristics of a complex system are the occurrence of a large number of parts with multiple nonlinear interactions that typically exhibit hierarchical self-organization under selective pressures ([16, 18]). The complexity is not accidental [17], but an inherent property of large systems. Simon states that the behaviour of a complex system may be studied by analyzing the behaviour of each component as well as their relationship with others. We feel that a software offshore outsourcing situation is built just like a complex system. System dynamics approaches complex systems behaviour from two perspectives: relationships between components and the behaviour of individual components. The verse understanding of the costs that arise from offshoring project and risk management is inevitable. Interestingly, according to [19] only 25 % of companies achieve a cost reduction larger than 10 % through offshoring, despite the wide labour cost gap. This is accounted to transaction costs. We therefore need to understand how the complex system is built up so as to manage the inherent risks of offshoring. The following Section introduces a system dynamics approach to the analysis of software offshoring projects.

3. System Dynamics approach to Offshoring

The system dynamics approach is used in order to formalize the basics for simulating offshoring projects. We recommend the use of eleven high-level elements (ref.

Figure **3**) so as to describe them. Each element contains a number of sub elements that further describe the high-level elements in detail.

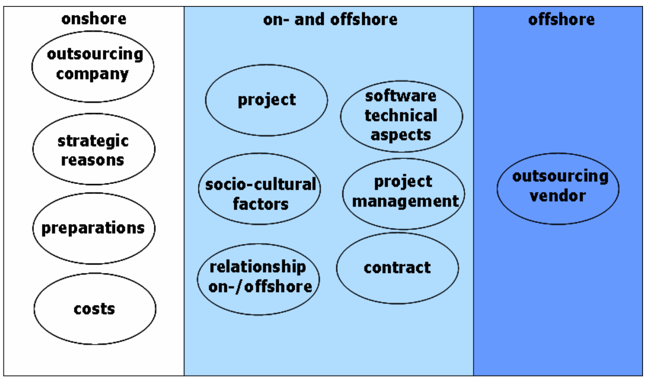

Figure 3: Components of offshoring

Figure 3 subdivides the elements into three groups: the onshore group, the on- and offshore group and the offshore group. The first group contains elements that the onshore side is responsible for. The second group, the responsibility of both sides and the third is that of the offshore side. Links between the single elements are not included for clarity reasons.

	preparations	strategic reasons	costs	contract	socio-cultural factors	software technical aspects	project management	project	onshore/offshore relationship
preparations		x	x	x	x	x	x	x	x
strategic reasons	x		x	x	x	x		x	x
costs	x	x		x	x	x	x	x	x
contract	x	x	x		x	x	x	x	x
socio-cultural factors	x	x	x	x			x		x
software technical aspects	x	x	x	x			x	x	x
project management	x		x	x	x	x		x	x
project	x	x	x	x		x	x		x
onshore/offshore relationship	x	x	x	x	x	x	x	x	

Figure 4: Interconnections between offshoring elements

The elements are strongly interconnected hence complicating the analysis (ref. Figure 4). Additionally, multiple sub elements may be part of each element. For example, the "cost" element entails the sub elements: "size" ([23]), "duration" ([24]), "complexity" ([24]), "interfaces" ([24]), "technology" ([23]), "specifity", "project specification" ([23, 14]), "test requirements" ([23]), and "onshore, offshore mix" ([23]). The sub elements in turn are connected with other elements. For example the element "test requirements" is connected with the "contract" element (ref [26]). The authors have defined seven aspects that need to be considered in [26] (test environment, test data, profiles for the performance tests, documents for users and for training, documentation of the architecture and design, test cases are based on real user cases and definition of procedures for difficult problems were not detected during the tests). These aspects are further connected with many other elements. Consequently, further research is required so as to make the system dynamics approach practical in the analysis of software offshoring.

4. Discussion / Summary

The study in this article is still work in progress. Interconnection between the components is broad (ref section 3). An offshore project is characterised by a complex technological system.[1] The complexity in the structure of the technological system is owed to interdependence between the elements that make up the system. The effects of these interdependencies between elements need to be taken into account because focusing on the element-specific properties may otherwise prove to be counter

[1] Hughes' ([20], p. 51) concept of technological system includes, apart from technical components, organizations, scientific texts, patents, and laws. Hughes ([20], p. 55) does acknowledge the usefulness of approaches that define systems solely in terms of the embodied technical components embodied.

productive due to negative effects of the combination. Thus the choice of elements cannot be independent of other elements in complex systems where elements function interdependently. The collective evaluation of these elements is crucial so as to effectively analyze the whole[2] system.

The deeper evaluation of the elements at the system level is complex. It has proven harder to find a system rather than to find a good element design, because the number of possible combinations between different variants of elements is exponential to the number of elements.

This is Simon's explanation "Suppose the task is to open a safe whose lock has 10 dials, each with 100 possible settings, numbered from 0 to 99. How long will it take to open the safe by a blind trial-and-error search for the correct setting? Since there are 10010 possible settings, we may expect to examine about half of these, on the average, before finding the correct one – that is, 50 billion settings." ([16], p. 194).

The evaluation of all possible combinations between elements follows the global trial-and-error strategy. Only global trial-and-error is effective in finding the optimal solution (cf. Alexander 1964 [1994]: 21) in complex systems. Using global trial-and-error in offshoring, ultimately amounts to trade off between a massive volume of settings. These settings can hardly be optimised in such a way that the end result really delivers practical results to the company that is using the software for offshoring.

Acknowledgments. The heading should be treated as a 3rd level heading and should not be assigned a number.

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[2] This does not imply that the whole system is superior to the sum of its parts. The whole system is different and not greater than the sum of its parts. ([21], p. 572).

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