Applying the OUTSHORE Approach for Risk Minimisation in Offshore Outsourcing of Software Development Projects

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Abstract: Outsourcing a software development project offshore is risky. Nonetheless, multiple software companies do this so as to lower costs or shorten the development period. This paper presents OUTSHORE - a novel approach to manage the inherent risk of offshore outsourcing. We demonstrate the results of a qualitative analysis based on twenty nine interviews. We develop fifteen hypotheses which define decision and risk factors in software development offshore outsourcing. Additionally these factors are used to build up decision support and risk controlling models that help minimize the risk of offshore software development projects.

1 Introduction

An organization outsources the software development project when it wholly or partially contracts out the software development activities to another organisation. This is referred to as "offshore outsourcing of a software development project" when one of the companies is remotely located. The diverse distribution of the activities all over the world causes a number of unanswered questions about realisation and successful implementation. The goal of IT-Offshoring is to uphold competitiveness in the global market by tactfully implementing all resources, information technology, skills and knowledge to guarantee a successful offshore outsourcing project which should indeed assist the company in its further global establishment. The strategic reasons for a company to opt for offshore software development are among others the need to speed up the time-to-market, to access the global resource pools, to profit from the around-the clock development, and to reduce the costs.

There actually exists a huge gap between the targets and the realised results. "You'll never have all the information necessary in making a decision and even if you did, it would be a foregone conclusion, not a decision." [Ma88] There hardly exists any business decision without an inherent risk. This is indeed the case in software development. Boehm states that the post-mortems of most unsuccessful software projects indicate that their failure could have been avoided. Quoting, “if there had been an explicit early concern with identifying and resolving their high-risk elements” [Bo91].

Software development has in the last decade evolved to be even more risky. Evasion or minimisation of the risk using some suitable methods of risk management is essential for success. Risk may be defined as the net negative impact of vulnerability, considering both the probability and the impact of occurrence. The risk may broadly be looked at from two perspectives: the economic and the managerial [MS87]. 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 depicts the risk as a danger or hazard to the potential positive realisation of a project, while risk is associated with its negative outcome. Thus, the risk management is the process of identifying assessing and taking steps to reduce risk to a tolerable level. The risk assessment includes activities such as risk identification, risk analysis and risk prioritisation while risk control involves risk-management planning, risk resolution, and risk monitoring. Risk management covers the handling with risk throughout the entire project; it is a continuous process focussing on the whole life cycle of one system.

Multiple risks of different nature are associated with offshore development (cf. [Sal07]). Generally, the success of an offshore project can be gauged by three parameters based on the satisfaction of the client: *quality*, *time*, and *costs* (cf. [GS98]). *Quality* is measured 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 compliance of the offshoring project to the allocated budget. An offshore project that fulfils the clients expectations, gauged by these three parameters is successful hence a failure. A failure may be caused by various reasons.

One of the major challenges for distributed software development is distance. Casey and Richardson [CR06] state that distance introduces barriers and makes the management of these tasks complex. The key variables for success (effective coordination, visibility, communication and cooperation [Co68], [Ka99]) are negatively impacted by distance. Consequently, the major challenge in the coordination and management of offshoring projects is the minimisation of these negative effects. Minimisation however requires a more detailed insight into the causes and effects of the undesirable outcome.

2 Research Method

The goal of this study aims at delivering methods and tools to support the company’s decision making as it considers outsourcing its software development project offshore. A three phase study was for this reason initialised (ref. Figure 1).

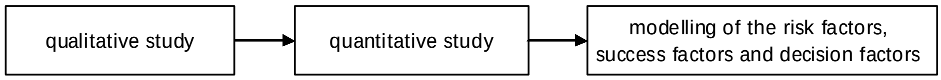

Figure 1: Structure of the study

Experts were interviewed in the first phase. The analysis of the collected data was based on the Grounded Theory ([GS67]). Fifteen hypotheses that are based on the analysis were formulated. An online questionnaire was then put into use in the second phase so as to verify the results of the first phase. Risk and decision factors were formulated in the third phase based on the results from the first two phases. They were later on evaluated in respect to their importance in offshore software development and with reference to literature (cf. [AW05, Go05, SW05, Mo04, and BIM05]) and also with the aid of expert opinion. Figure 1 illustrates the set up of the study. These phases are further dealt with more precisely in the subsequent sections.

We initially created an online questionnaire with a view to verifying the precision of the hypothesis as well as ascertaining the experience that we gathered from the interviews. The results of the questionnaire were analysed using statistic methods. The results were eventually used for both the modelling and implementation of decision support software for offshore outsourcing of software development projects.

Twenty-nine interviewees from seventeen different companies that practice software offshoring were interviewed in the first phase. The interviews were carried out from September 2006 until December 2006. Each interview lasted about ninety minutes. The interviewees represented diverse field of activities like development, consulting and project management. The interviews were carried out as half structured discussions where a questionnaire with a predefined outline and about fifty questions in eight different categories was used. The interview was hence diverse and the interviewees could freely give an account of their experiences.We nonetheless had a guideline. The categories and their respective goals are summarised in Table 1.

Category	Goal
General information.	Information about the company, the interviewees as well as their experience respective areas.
Strategic reasons and decisions.	Reasons and the type of offshoring.
Software technical aspects.	Which parts of the software development project were outsourced offshore? What approach and which tactics were applied in the software development process?
Cost calculation.	Conformity of the cost and effort calculation with the actual costs / effort.
Preparations	What preparations were made in respect of technical equipment and environment, organisation structures etc. before the project have been started?
Project management	How was the project management organised?
Form of contract	How was the contract between the client and contractor

	formulated? Were there any modalities, sanctions etc?
Challenges in the project	Which cultural, linguistic and organisational challenges and problems were encountered within a project and what were the solutions?
General problems (recapitulation)	Problems and experiences that could not be mapped into any other category.

Table 1: Categories of the questions and their goals

The first phase of this study leads us to a possible conclusion that the companies are indeed fully aware of the challenges and risks of offshoring Nonetheless, companies were at the same time not in a position to name or estimate the existing challenges or risks of offshoring. They were however willing to follow a predefined standard course of action in offshoring projects. Decision support on the object and form of offshoring was considered quite necessary. An online survey was conducted in the second phase so as to verify the hypothesis formulated at the end of the first phase. The questions were hence formulated based on the questions in the first phase. They were however closed questions that aimed at reaching solid results. Interviewees were only interviewed once. Those interviewed in the first phase were not interviewed in the second so as to avoid any partiality errors. This gathered data conformed to the data taken from the first phase and thus asserting the previously formulated hypothesis. A number of risk, success and decision factors (e.g. cultural distance, experience in offshoring, process maturity [AW05, Go05, Mo04, Sal07]) were derived from the hypothesis and current literature for use in the third phase of the study.

3 The OUTSHORE approach

The OUTSHORE approach has been used in the following section to minimise the risk of offshore outsourcing software development (short: offshore development) projects. The approach is subdivided into three parts (ref. Figure 2): the *qualitative* decision support, the *quantitative* decision support and the *risk control*. The first two phases will consequently be described more precisely, as the risk control is out of the scope of this paper.

3.1 Qualitative Decision Support

Qualitative decision models aims at supporting the decision making from a non-monetary perspective by means of quality criteria. Various models have been presented in the current literature. Qualitative models focus on the strategic goals and core competency of the company (cf. [Vo06], [FP98]). We have developed a qualitative model that is based on the study presented in Section 2. It not only focuses on the organisational components but also on the issue of whether a software development project or part of it is appropriate for offshore outsourcing.

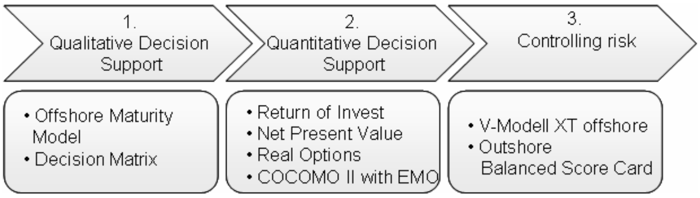

Figure 2: The OUTSHORE Approach

The offshore maturity model evaluates the outsourcing capability of a company in respect for its suitability for offshoring. It hence provides a tool for risk management. The gradual improvement should however be upheld, because the necessary activities can be read from the model. The following dimensions are considered while rating the buyers' maturity: Strategy, operational structuring, experience in offshoring, maturity level to build up the risks, and hardware assistance (ref. Figure 3).

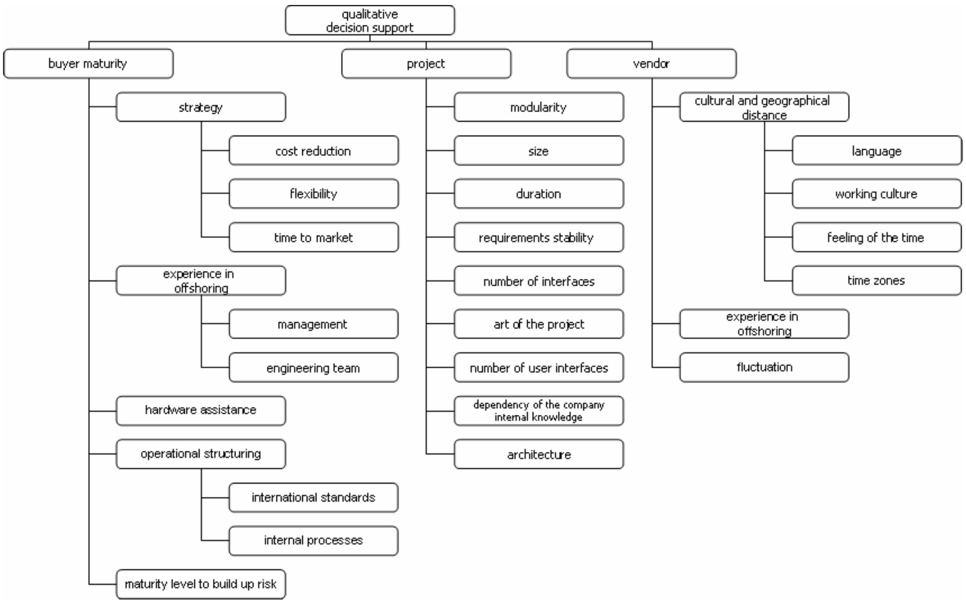

Figure 3: Factors of the qualitative decision support derived from the study

These dimensions are subdivided and evaluated by several critical success factors. The maturity level is evaluated from each and every stated dimension. The evaluation is conducted as follows:

1. Verification through the response of questions →
2. They create a base for the evaluation of the offshore activities →
3. They get evaluated by their possible influence on the offshore project →
4. Aggregation to a maturity level.

This ought to provide the companies with a decision support system that checks their preparations for offshore development projects. A decision matrix on the planed project as well as the vendor preferences in addition to the buyers' maturity level is needed so as to provide a qualitative decision support tool which considers all relevant factors of an offshoring decision [cf. AW05]. The dimensions of this decision matrix are depicted in Figure 3.

3.2 Quantitative Decision Support

Decision that is based only on qualitative attributes is narrow ([Ela03]). Each project should contribute on a long-term basis to the generation of value (cf. [Vo06]). Offshore development projects ought to take account of this. Cost reduction, flexibility, and faster marketing time increases the enterprise value. Qualitative decision models are thus single-handedly insufficient for decision making since IT projects may often alter the value [FP98]. We thus bring up the shareholder value concept: The value for the company must be estimated using evaluation methods. The authors therefore accordingly introduce a quantitative decision model. It consists of four different independently usable and loosely connected parts that may be utilized for quantitative decision support: 1) *Return of Investment* (ROI), 2) *Net Present Value* (NPV), 3) *Real Options* and 4) *COCOMO II*.

We will build up the different steps of static to dynamic to flexible valuation methods. The first method (ROI) is simply static and it does not take into account any generation of value or time value of money. The second (NPV) is a dynamic method which takes these points into account. It however has no possibility of building up future scope of actions. This possibility is inherent to the real options analysis, which is the third used valuation method. We finally integrate an amplification of the COCOMO II model into our approach so as to give a general overview of the cost drivers and the estimated overall effort. Accordingly, each method supports the risk management in offshore development.

3.2.1 ROI - Undesirable Outcomes of Offshoring

ROI is a financial tool for gauging the economic return of a project or an investment. It is used to rate 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 (cf. [Be04]):

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

If the result of the calculation is lower than zero, the offshoring project may possibly be unsuccessful. The major challenge in the use of ROI is the determination of the variables that are mostly eventually identified after the project is completed. Therefore ROI is predominantly utilizable as a rough rule of thumb (cf. [Go05]). The calculation of the ROI for offshoring is comparable to the regular ROI calculation, except that it considers the savings instead of profit. It therefore goes away from the custom ROI investment calculations.

3.2.2 Net Present Value

The NPV is a standard application for investment decisions of long-term projects. It is widely used by companies. It considers the cash flow. Figure 4 shows a very simplified software development process with five phases. Based on that, software development projects have three basis of cash flow [Vo06]: Initial investment[1], Labour costs[1,2,3], and Outcome[3].

The formula of the NPV-calculation looks as follows: $c_0 = -I + \sum_{t=1}^{T} C_t (1+i)^{-t}$

I - The capital outlay at the beginning of the investment time ($t = 0$)
t - The time of the cash flow
T - The total time of the project
i - The discount rate
C_t - the net cash flow (the amount of cash) at time t.

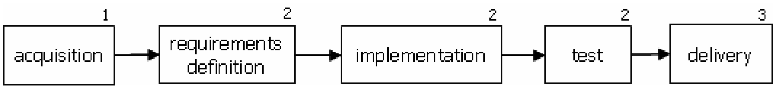

Figure 4: A simplified software engineering process

Changes within an offshore development are limited. There aren't many options in offshore development as shown in the offshore software development process (ref. Figure 5). All changes in an offshore development process stream directly into the existing cash flows. No additional parameters are needed for the representation of the following tasks in the NPV cash flow: Acquisition and definition of the offshoring tasks, vendor search and contract negotiations, training and additional initial investment, communication between the partners, and integration and testing. The only additional cash flow that does come about, even when the formula of the NPV isn't altered is the payment of the provider[4] as depicted in Figure 5.

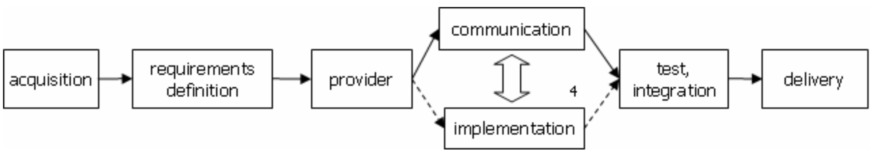

Figure 5: An offshore software engineering process

3.2.3 Real Option

The real option analysis (ROA) is based on dynamic investment analysis. It is used as a capital budgeting tool because of its flexibility in management decision making when accounting for the value of future (cf. [Amr99a]). The literature reports about studies where ROA has been used to value a single project in go or no-go decisions (cf. [Amr99b], [Di94], [Tri96]) or for decisions considering project portfolios (cf. [Bar04]). Furthermore, some studies consider the determination of the optimal timing of IT investment in point-of-sale debit card services [Ben00] or to justify an IT platform adoption decision to upgrade from one release to another one [Tau00]. The OUTSHORE approach takes a different focus on the decision to be made. We focus on evaluating how to go: inshore or offshore, instead of valuating the go or no-go decision

Economically, the risk is built up through uncertainty which in turn adds up to an unexpected expectancy value. The decision is built up as an activity, which might be taken [Hu06]. By doing so, the increased flexibility, which is said to be one of the most important strategic goals of outsourcing software development offshore, is particularly taken into account. The Real Options that are significant in offshore development projects are: deferral option, expansion option, abandonment option, temporarily shut-down option, and new investments option. The real option analysis framework is depicted in Figure 6. We plan to implement the real options for two different strategic goals: cost reduction and flexibility. We decided to build up the real options through the black-scholes model which is not 100% exact but it can be used as a lower limit. We use the mean reversion process as the fundamental method.

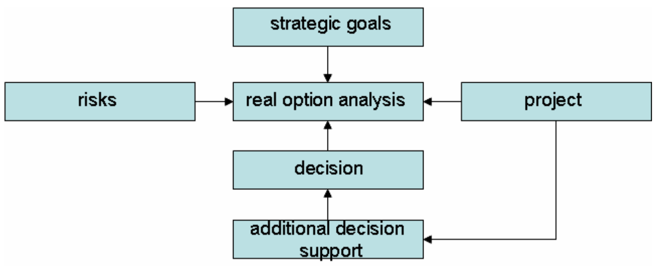

Figure 6: Real Option Analysis Framework

3.2.4 COCOMO II

The theoretical basics of COCOMO were designed in the seventies by Barry Boehm to establish better and more realistic estimations for software projects [MS87]. He also introduced the first version (COCOMO 81) in 1981. Quoting, "The purpose of this model is […] to equip you to deal with software engineering problems from the perspective of human economics as well as from perspective of programming." [Co68]. The Software engineering world has in the meantime changed a lot. These changes have exerted influence on the original COCOMO model and resulted in the COCOMO II [APR98], which was published in 2000 ([BABC00]).The basic version of COCOMO estimates the effort of a software development project in person month (PM), that is normally calculated with 152 working hours. The COCOMO II enables the use of source lines of code and function points as reference parameter for the calculation of the Size (S) of the project. We focus on the post-architecture model: a detailed model and widely used version of the COCOMO II. It provides a deep insight into the cost driver, but it however depends on a clear definition of the life-cycle and software architecture. Cost drivers are characteristics of the software development that impact on the effort of the software development project. The effort equation of COCOMO II post-architecture model looks as follows:

$$PM = A * Size^{E} * \prod_{i=1}^{17} EM_{i} \qquad (1)$$

PM: Person Month

A: Constant (2.94 for COCOMOII.2000)

Size: KSLOC (Kilo Source Lines of Code; Kilo = 1.000, SLOC, Function Points)

E: Scale Factors

EM: Effort Multipliers

The constant A is a calibration factor. It depicts the dimension of the productivity. The standard value for COCOMO II is 2.94. It should however be calibrated with the aid of the company's historical project data. Scale factors have an exponential influence on the effort of a software development project. These factors are cost drivers as well as the effort multipliers (EM). Effort Multipliers are classified in various categories ranging from very low to extra high. They have a linear influence on the effort. Numerical values have been assigned to these categories. They are thus quantified with a numerical value from the COCOMO-tabulations [APR98]. The nominal value of a cost driver is 1.0. If the value is higher than this nominal value, the estimated effort of a software development project increases. If the value is below 1.0, the estimated effort of a software development project then decreases. Seventeen EM exist within the post architecture model (ref. equitation 1) [APR98].

The amplification of COCOMO II has been carried out in three steps (cp. Figure 7):

Figure 7: The amplification of the COCOMO II

In the first step, *identification*, we identified the additional cost drivers for distributed development projects. Current literature states that multiple risk factors are linked to software offshore outsourcing [PH04], [Be04], [KN96], and [HBR04]. We additionally conducted a qualitative survey based on semi-structured interviews with 29 interviewees from reputable German software manufacturers. This research was an explorative research to gain knowledge about the cost drivers of offshore outsourcing projects. We applied the grounded theory, which was invented by [GS67] to identify the major risks. These risks are the cost drivers of offshore development projects. We then analyzed the existing cost drivers of the COCOMO II with a view to checking their relevance to the global software development. We found several factors which are affected by offshore development [BeMä07]. The direct use of the COCOMO II in the offshore development is however insufficient, because it does not cover the complexity of the topic. We consequently decided to amplify the model. We used the modular composition of the COCOMO II to integrate the additional cost drivers into the model. Cost drivers in [BABC00] can be kept or omitted by the user. We accordingly identified new cost drivers that are typical in offshore development and added them to the model.

We used *Effort Multipliers* to build up the new costs drivers, because there haven't been any observations made on new scale factors arising through global software development [Br95]. The current research attempts to reduce the risks and the development effort of offshore development. Thus cost can be saved if the additional effort doesn't turn out to be too high. We added 11 new Effort Multipliers to the equitation and named them Effort Multipliers Outsourcing (EMO) (ref. 2). These factors were subdivided into 4 groups: Outsourcing Factors, Buyers Outsourcing Maturity, Providers Outsourcing Maturity and Coordination Factors.

$$PM = A * Size^{E} * \prod_{i=1}^{17} EM_i * \prod_{j=1}^{11} EMO \qquad (2)$$

Our first step was to identify the additional cost factors of offshore development projects: eleven additional factors were identified and defined as the starting point for the amplification of the COCOMO II. The second and third steps (ref. Figure 7), were to categorize these additional factors and to quantify them with numerical values. This has been done according to the COCOMO II categories and values. We tried to develop our categorization on theoretical thoughts, literature research and most of all on expert opinion. We are aware of the lack of validation because of the missing data base of actual offshore development projects. But we are confident that the approach is a step in the right direction and it will eventually be calibrated further.

4. Summary and Outlook

This work presents the first two phases of the innovative approach (OUTSHORE) to support the risk minimisation in software offshore outsourcing. OUTSHORE is based on a set of decision, success and risk factors for successful offshore development resulted from a study. The results are reassigned into qualitative and quantitative decision support models and into risk controlling mechanisms. They are used to build a decision support toolset providing new chances for risk analysis, planning and monitoring of offshore development projects. In the first place, a decision Matrix and the offshore maturity model are generated in order to help companies decide whether the company and the software development project are appropriate for offshoring. Secondly, the assumption by using the shareholder value attempt is quantified. This was implemented using the net present value and the option price. An amplification of the COCOMO II is additionally provided so as to estimate the effort of offshore development projects. Together with the third phase, risk controlling (cf. Figure 2), the OUTSHORE approach reduces the risks of software offshore outsourcing by providing a decision support system for determining whether the software development project and the outsourcing company are appropriate for outsourcing. It further provides an assisting model for the realisation of the offshore development project and hence helps to reduce risks.

Acknowledgements

This compound project is a collaboration of the Forschungszentrum Informatik (FZI), the institute AIFB of the University of Karlsruhe and several industrial partners. It has had a runtime of 36 months. The goal of the OUTSHORE is to determine the effect of critical success factors on an offshore outsource software development project.

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