Cost-Savings in Global Software Engineering – Where is the Evidence?

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INTRODUCTION

The popularity of offshoring (developing software in low cost countries) keeps growing fueled by the rumors of significant cost-savings. Despite claims that offshoring is motivated for less offensive reasons than simply reducing costs, the main driving force has always been related to costs[2]. The realization of economic benefits, however, seems to be mystified, resulting in a lack of clarity. On one hand, industrial experiences demonstrate that the assumed benefits are not always achieved and thus shall not be taken for granted[5]. On the other hand, senior executives are easily driven away by promised salary differences. An industry report about a successful offshore outsourcing project with timely delivered good quality software mentions attractive hourly rates in India versus Germany and consequent "significant cost saving" expressed as "several million €/year"[1]. But how trustworthy is such claims? Is there any actual evidence and transparency in the way costs have been calculated? Other industrial studies indicate that cost-savings are not as drastic as pure salary comparisons suggest, due to additional managerial overhead[5], [6]. In fact, the benefit of low-cost labor must be weighed against the risk of missed deadlines, dissatisfied users, and failure to reduce development costs. So what shall we trust? To shed some light on this matter, we trace the claims of cost-savings and offer our judgment of the evidence.

Evidence is the basis for decision-making. The most commonly known use of evidence in society is probably in law. Taking the juridical system as a metaphor, we here extend, summarize and use a concept denoted the evidence profile, originally proposed by Wohlin[7] (see Sidebar I).

EVIDENCE OF COST-SAVINGS

To judge the evidence of cost-savings in GSE we reviewed more than 500 articles on GSE and found that only 14 articles presented evidence of cost-savings (see Table 1). We identified projects and companies that reported both achievements and failures to achieve cost-savings. For more details see Appendix II.

We profiled the evidence (see Figure 1), and found that the results are inconclusive. The number of studies for and against cost-savings is almost equal. All our attempts to determine what influences success or failure were unsuccessful – we found no relation to sourcing models (outsourcing versus insourcing) or the number of sites (2 versus 3+).

It is important to notice that none of the individual studies could be judged as trustworthy evidence. Although some studies are based on a large number of projects, and different means of data collection (surveys, interviews, and documentation analysis), traceability of calculations and economic data is missing. As such, the verdict of a judge or jury would be that there is no reliable evidence in favor of cost-savings in GSE or against it.

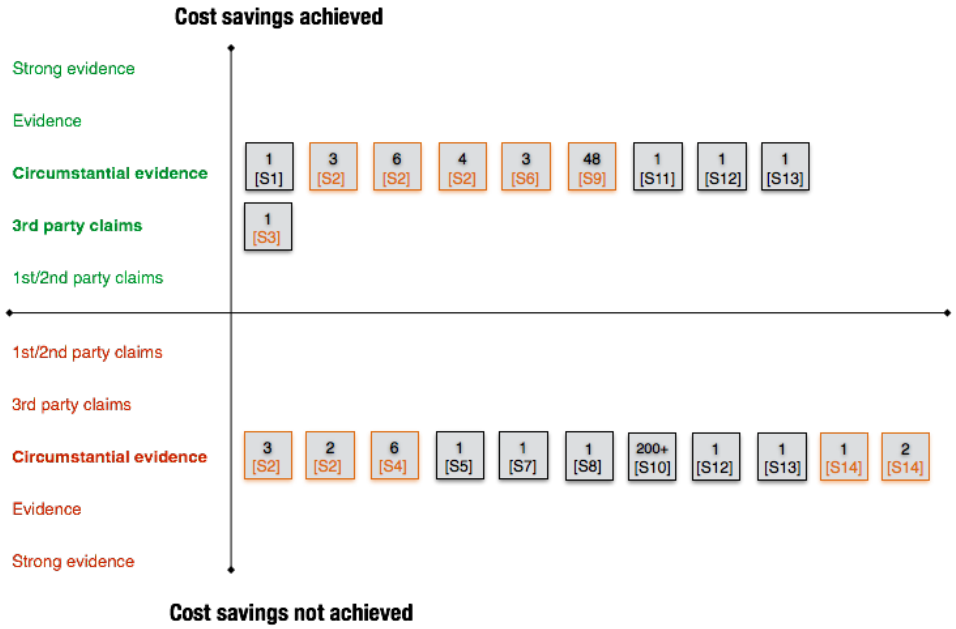

Figure 1. Evidence profile for cost-savings in GSE: the boxes indicate studies and include a reference to the Appendix, studies conducted by an author(s) with a likelihood for a vested interest are highlighted in orange color.

Table 1. Sources of evidence

Ref	Company	Number of sources	Type of work	Sourcing model	Sites involved	Result	Range of savings/losses	Calculations
S1	HP	1 collaboration	Remote customer support	Insourcing	US, Ireland, India	Achieved	10x saving	N/A
		1 collaboration	Remote support work				Further 3x saving	N/A
S2	Nokia	3 projects	Basic complexity projects	Outsourcing	Various (Finland, US, Central/Eastern EU, India, China, and other)	Achieved	N/A	N/A
		6 projects	Moderate complexity projects			Achieved	N/A	N/A
		4 projects	Complex projects			Achieved	N/A	N/A
		3 projects	Moderate complexity projects			Not achieved	N/A	N/A
		2 projects	Complex projects			Not achieved	N/A	N/A
S3	Various	Many	Telecom and automotive projects	N/A	N/A	Achieved	10-15% after 2-3 years	N/A
S4	Schlumberger	2 projects	Complex and knowledge intensive development tasks	Outsourcing	N/A	Not achieved	N/A	N/A
S5	N/A	1 project	Development and maintenance of financial software	Outsourcing	US, US, Ireland	Not achieved	N/A	N/A
S6	Nokia	2 projects	Test automation	Outsourcing	Finland, India	Achieved	N/A	N/A
		1 project	Test automation	Outsourcing	Germany, China	Achieved	N/A	N/A
S7	N/A	1 project	Improvement of a large legacy banking application	Insourcing	Finland, Eastern European country	Not achieved	N/A	N/A
S8	N/A	1 collaboration	Complex system development	Outsourcing	Norway, India	Not achieved	N/A	N/A
S9	N/A	19 projects	Agile projects	Various	Various (Europe, Asia and the Americas)	Achieved	> 50% in 20% of projects, 25-50% in 60% of projects	N/A
		29	Structured projects	Various	Various (Europe, Asia and the Americas)	Achieved	> 50% in 19% of projects, 25-50% in 31% of projects, 10-25% in 50% of project	
S10	Phillips	> 200 projects	Consumer electronics product software development	Various	Asia, Europe and India	Not achieved	2 to 3x more costly than collocated	N/A
S11	N/A	1 project	Continuation of development of a payroll management system	Outsourcing	Norway, Russia	Achieved	35-40%	N/A
S12	N/A	1 project, phase 1	Application development and maintenance for a telecommunications carrier	Outsourcing	US and US	Achieved	Dramatically	N/A
		1 project, phase 2		Outsourcing	US and India	Not achieved	USD 275 millions in 5 years	Salary comparisons
S13	N/A	1 project	Embedded software development	Outsourcing	US, India	Not achieved	N/A	N/A
		Several projects	Selected projects with well-defined deliverables	Outsourcing	US, India, India, and unclear location	Achieved	10-15% decrease than onshore costs	N/A
S14	IBM	2 projects	Web application development with follow-the-sun approach	Insourcing	US, India	Not achieved	Significant decrease in gross profit	Net value and gross profit
		1 project	Web application development with	Insourcing	US, India	Not achieved	Significant net loss with	Net value and

Despite inconclusive results, we still made a few interesting observations as follow.

WHO ACHIEVES COST-SAVINGS

Salary differences attract companies to global software development[S1]. However, economic benefits are not for everyone. Some associate big savings in GSE with basic projects[S2] and well-defined processes and deliverables that do not require much control[S3], [S13], while highly distributed projects achieve 10-15% cost reduction and only after a 2-3 year learning curve[S3]. Also outsourcing separate processes, such as test automation, has yielded cost-savings[S6], although the authors admit that projects faced minor slippages in schedules, hidden costs and quality concerns. In contrast to many other studies, our findings suggest that sometimes sourcing complex development tasks can also finish successfully and provide cost-savings[S2].

WHO FAILS TO ACHIEVE COST-SAVINGS?

Failure is often associated with complexity. This can be related to knowledge-intensive processes[S4], domain specificity[S2], [S8] or technical nature, i.e. developing embedded software[S13] or evolving and maintaining legacy systems[S5], [S7]. Also follow-the-sun approach, as suggested by other studies, in our investigation was unsuccessful[S14].

Despite salary-based reductions on the surface, the failure to deliver the working software turns the very discussion of the cost-savings obsolete[S2], [S12]. And while certain initially troubled projects manage to recover[S4], high expectations of cost-savings especially on an immediate basis are not always met due to significant management overhead and longer than expected duration of the ramp-up stage[ibid].

THE VOICE OF THE JURY

MARIA LARSSON
Head of Software Development & Integration at Aachen R&D center, ERICSSON

"My experience of offshoring to low cost countries, and if cost-savings are achieved or not, is based on setup and time perspective. Where I have seen benefits from a cost perspective is when long term partnership has been built up between sites and areas of responsibility has been distributed to avoid overhead in coordination and reduce dependencies. We have a tendency to underestimate cost that is not visible in the hourly rate such as attrition, increased need for travel, expertise knowledge buildup etc., on the other hand values such as global representation and access to other markets are also hard to put a price tag on.
To calculate and find the evidence is complex and need to cover several aspects, which I also find here. My conclusion from the evidence profile is that the facts are hard to find which is also supporting my own experience.
Even if this study is not providing the evidence of cost-savings I find this kind of research valuable for global companies like Ericsson to secure that we benefit from our own and also other companies experience and identify what key areas to address when taking the decision to do offshoring or not with the purpose of cost-savings."

TORMOD SVENSEN
Director of Operations at QHSE, Integrity and Optimization, DNV GL SOFTWARE

"Research on cost-savings is important for business to take better decisions. One weakness with papers reporting cost-savings in this study is that they do not include any calculations and economic data, which make it impossible to learn from them.
When we consider cost we need to consider many factors, including the business model. We tried some years ago to get an economy around offshoring "pure coding". A cost calculation was never needed to know it was unsuccessful, because most of the code was never used due to quality issues. From our first offshore attempt, we also realized that writing code is such a small part of our total value chain. Understanding cost calculation, we need to look at the total value change. And this is very complex.
Our business is about producing licenses that we sell worldwide. We also do "bespoke development" close to a single customer. For us to succeed we need to be close to the market. If we're building something the customer does not want, it does not matter if we accomplish it, on time, on budget and with high quality.
Finally, to get the good people in any country you need to pay. However, salary is not the only expenditure because you need to travel a lot. Our key learnings support the recommendations suggested in this paper, specially the recommendation of careful planning."

CONCLUSIONS AND RECOMMENDATIONS

The premise of cost-savings is appealing. Many studies promote cost-savings based on salary differences[S5]. Such statements promoting the idea of significant cost-savings, however, became targets for criticism[S3]. Our investigation suggests that the evidence of cost-savings in GSE is inconclusive.

For companies considering offshoring we give the following recommendations:

- **Perform careful planning:** On top of regular risks, GSE projects are fraught with a variety of specific risks (e.g., wrong selection of outsourcing providers[S6], high turnover[S8] etc.). As such, they are doomed to failure if not carefully planned and executed.
- **Don't be carried away by salary rates:** Many studies warn that cost-savings in GSE are lower than expected[S3], [S4]. Strategies that base work allocation on skill availability and salary-savings, results in imbalanced workload distribution and negatively affects quality and cause rework[8].
- **Think of what you compare:** Take into account what you pay for – working hours, or results. As one of the studies reported, Malaysian engineers who cost half of what Irish engineers cost, lack technical knowledge and extensive relevant experience, which significantly affect the productivity levels[S5]. Similarly, a perceived upfront benefit of significant eight-fold salary saving in case of US versus India[S1] was affected by coordination costs and productivity differences.
- **Account for hidden costs:** GSE projects are often associated with hidden costs – additional management effort and insufficient performance[S5], project delivery failures[S2], [S12], and insufficient quality with resulting rework[S8], [8]. Significant investments are required (often onshore) to compensate the initial gaps in specific knowledge, mutual understanding and joint experience.
- **Don't expect immediate cost-savings:** Cumulative savings typically go down before rising up[2] – companies need to invest and climb up a learning curve before reaching the breakeven point and achieving economic benefits. Companies going offshore often encounter problems and failures, before making it work, if they stick with their offshore decision. The time needed to reach breakeven may take 2-3 years to achieve 10-15% economic benefit[S3], or 3-4 years[S9]. Evidently, offshoring may not be the right strategy for companies that expect immediate economic benefits or plan short-term projects.
- **Approach cost calculations carefully:** Models for calculating the true cost of offshoring software development are lacking[S1], and companies shall put effort into judging resulting development costs reliably and fairly[6].
- **Note that at the end it does not always work out:** Suggesting that companies shall stick to their collaborations until it works out waiting for economic benefits to emerge we do not mean that success is guaranteed. Critical risk assessment shall be performed with due diligence, since some circumstances might doom collaborations to inevitable failure, no matter how much is invested[S8].

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SIDEBAR 1 – EVIDENCE PROFILE

The juridical systems are not the same in different countries, but they are all based around the concept of evidence and some key roles: judge, prosecutor, lawyer and defendant. Assume that the metaphor is used as follows.

Defendant is the "object of study", which in our case is an ability to achieve cost-savings in offshoring. The objective is to decide in favor or against it based on the available evidence.

Prosecutors and lawyers are authors of the papers we reviewed who provided different evidence with respect to the object of study. Their role is based on whether they argue for or against the cost-savings.

Judge or the jury are the decision-makers, be it senior executives, project managers interested in understanding the premise of cost-savings in offshoring or GSE researchers. These are stakeholders intending to make a decision based on the available evidence.

In this article, we use evidence presented in the form of articles and papers, but in practice, it could also be other sources. The decision-maker (judge) should decide whether a source of evidence should be viewed as admissible or not. The decision-maker should also decide what constitutes an actual piece of evidence. For example:

- A survey contains many responses. Is this one piece of evidence or is each response a piece of evidence?
- A paper may describe several case studies. Is each case study a piece of evidence or is it the aggregation of the case studies?

These examples illustrate some of the challenges when evaluating software engineering evidence. We recommend using the objective of the authors (prosecutors and lawyers) as the basis for deciding what a piece of evidence constitutes. If the objective is to present a survey then that is a piece of evidence, not each response. Similarly, if the authors drive a joint conclusion based on

several case studies in a company then the aggregation is the piece of evidence and not the individual cases. Of course, then an aggregation might be perceived as a stronger piece of evidence than the individual case studies.

Wohlin[7] provides a mapping of evidence in law to evidence in software engineering. For software engineering, the following five levels of evidence with their expectations are proposed:

5 – Strong evidence: a well-documented controlled experiment with representative participants or a cross company multi-case study, and the studies are conducted by researchers who are independent from the object of study. The research should be published after peer review.

4 – Evidence: a well-documented controlled experiment with non-representative subjects, a series of case studies within a company, or a well-documented single case study, published in a peer reviewed conference or journal, and published by independent researcher with respect to having a vested interest.

3 – Circumstantial evidence: a well-documented controlled experiment by anyone having a vested interest, a single case study, or a well conducted survey with a representative sample, and published in a peer review conference or journal.

2 – Third party claim: an experience report, lessons learned, or a non-representative survey, and published anywhere but not by anyone having a vested interest.

1 – First or second party claim: any information published by the inventor or by anyone else having a vested interest (for example, tool developer).

When the evidence is gathered and evaluated, the decision-maker shall take into account several aspects that may influence the final judgment:

- **Quality of evidence** – an eyewitness may be perceived as very reliable or not. This may be due to exactly what a person remembers about a situation. Reliability of evidence comes from triangulation, i.e. different pieces of evidence corroborate each other.
- **Relevance of evidence** – given the situation some evidence may be viewed as more relevant than in other cases. For example, some pieces of evidence may be more important for certain type of systems.
- **Aging of evidence** – this relates to technology change and hence evidence may have aged too much and hence not being perceived as relevant any more.
- **Vested interested** – evidence given by a person who has a vested interested in the outcome must be viewed differently than if the person is perceived as being objective. For example, evidence reported by researchers affiliated with the same company where a study was conducted has a higher risk of vested interest than that reported by independent researchers.
- **Strength of evidence** – this refers to the strength of the evidence as such, i.e. along the types of evidence listed above. However, the previous four bullets may affect the perceived strength of the evidence.

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ONLINE CONTENT

SIDEBAR 2 – HOW WE CONDUCTED THE STUDY

The evidence profile can be applied following a five-step process described next.

1. **Identify relevant sources of evidence:** This may include identifying relevant literature taking different criteria into account such as the context of the evidence (e.g. application domain) and age of evidence (e.g. articles older than a certain number of years are not included), and potentially also evidence being available in industry (e.g. the company interested in the evidence).
2. **Data extraction:** Data should be extracted from the sources identified. This includes both contextual information and information related to the research question (in this case cost-savings or not in GSE).
3. **Determining the number of data points from an evidence perspective:** The actual number of data points from en evidence perspective should be determined. This should be done so that the persons involved in the classification of the evidence have the same view of the pieces of evidence to be evaluated. This is preferably done individually and the discussed by the persons involved resulting in an agreement.
4. **Judging the strength of the evidence:** Each data point from step 3 is judged individually first using the five levels of evidence listed above. Based on the individual scores, the persons come together and agree on a score on the strength of the evidence.
5. **Evaluating vested interest:** It is important to take vested interest into account. The simplest classification is to view vested interest based on the presenter's relationship to the pieces of evidence, for example an author of a paper presenting results of their own employer would be viewed as a vested interest.

Here we present how we conducted our study applying the five-step process to guide the review of a number of empirical studies on GSE. The review involved two researchers (first two authors) who retrieved and analyzed all research contributions to the main thematic conference in the area, the IEEE International Conference on Global Software Engineering (ICGSE) from 2006 until 2014, and the primary studies cited in 17 relevant systematic literature reviews. In total, 530 unique papers were analyzed, that is, 173 full research papers and 419 primary studies.

Study selection (process step 1)

All papers included in the review were screened for relevance to our investigation by searching in the full text for the following keywords: *cost, salar*, saving, expens*, overhead, save* and *wage*. Papers that did not mention any of the keywords or did not use them in relation to costs in GSE, were judged as *irrelevant* (410 papers). Papers that contained the keywords (i.e., judged as *relevant*) were analyzed and grouped into two categories: those that *only mentioned* (106 papers) cost-savings briefly and those that *provided evidence* (14 papers) about cost-savings. At this point, we treated all claims regarding cost-savings as candidates for evidence.

To reduce the researcher bias, the two researchers involved in the selection process performed the relevance analysis independently. Then, the results were compared and disagreements resolved through discussions.

Data extraction (process step 2)

Included papers were then reviewed and data regarding the cost-savings was extracted in two steps.

First, we used narrative analysis and open-coding techniques to identify the pieces of evidence related to cost-savings. To increase the validity of the outcome, the two researchers started by reading a subset of papers and then discussed the results to compare the coding and align the approaches. Afterwards, the rest of the papers were coded by both researchers and iteratively compared and discussed.

Next, the context was extracted for each empirical study for further analysis – data about the research method and sources of evidence, sourcing strategy (offshore/onshore outsourcing/insourcing), number of sites and their location, industrial domain, company information, and type of work being sourced.

Data analysis and synthesis (process steps 3-5)

The extracted evidence was then classified and evaluated. This step involved all three researchers (first individually and then jointly). We read the extracted pieces of evidence and grouped them into two main categories – *Cost-savings achieved* and *Cost-savings not achieved*. The evidence was further judged according to its strength, and risk of vested interest (as outlined in Sidebar 1).

The synthesis of the evidence was guided by the categories and context information that emerged during the data analysis.

APPENDIX: THE LIST OF INCLUDED STUDIES

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