Calculating the Extra Costs and the Bottom-line Hourly Cost of Offshoring

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***Abstract*— Offshoring software development activities to a remote site in another country continues to be one of the key strategies to save development cost. However, the assumed economic benefits of offshoring are often questionable, due to a large number of hidden costs and too simple cost calculations. This study is a continuation of our work on calculating the true hourly cost that includes the extra direct and indirect costs on top of the salary-based hourly rates. We collected data from an empirical case study conducted in a large international corporation. This corporation develops software-intensive systems and has offshored its ongoing product development from Sweden to a recently on-boarded captive company site in India. In this paper, we report a number of extra costs and their impact on the resulting hourly cost as well as the bottom-line cost per work unit. Our analysis includes quantitative data from corporate archives, and expert-based estimates gathered through focus groups and workshops with company representatives from both the onshore and the offshore sites. Our findings show that there is additional cost that can be directly or at least strongly attributed to the transfer of work, working on a distance, and immaturity of the offshore site. Consideration of extra costs increases the hourly cost several times, while the performance gaps between the mature sites and the immature site leads to an even higher difference. As a result, two years after on-boarding of the offshore teams, the mature teams in high-cost locations continue to be "cheaper" despite the big salary differences; and the most positive hypothetical scenario, in which the company could break even, is unrealistic. The implications of our findings are twofold. First, offshoring of complex ongoing products does not seem to lead to short-term bottom-line economic gains, and may not even reach breakeven within five years. Second, offshoring in the studied case can be justified but merely when initiated for other reasons than cost.**

Keywords—Global software development, offshoring, offshore cost; software transfer; hidden cost; extra cost; case study; empirical; large-scale software development.

I. Introduction

Tight budgets and shortage in skilled people motivate many companies to utilize software developers in emerging countries. Unfortunately, decisions to offshore software development overseas are often made on the basis of the visible costs, i.e. the salaries that are significantly lower while skilled labor is easier to find [1], [2]. As a result, many large companies have established their branches in so called 'best-cost countries' and continue to employ people to do the software work shipped from the high-cost countries.

While there are a lot of studies indirectly referring to offshoring being a common cost-saving strategy, there are very few studies that substantiate the magnitude of cost-savings or losses from offshoring software work [3]. The vast majority of the studies that share the actual cost estimates often use percentages and intervals, are opinion-based or do not disclose any calculation algorithm behind the estimates. For example, Burger mentions attractive hourly rates in India in comparison with those in Germany, and claims to have achieved "significant cost saving" expressed as "several million €/year". [4]. Based on a survey of 48 projects and 18 interviews in 13 Swiss companies, Estler et al. [5] demonstrates that all of the respondents reported some degree of cost savings from offshoring software development. However, this and many other similar studies are opinion-based; there is no rigorous, transparent, and consistent way of reporting cost savings from well-documented offshoring cases that would result in strong, trustworthy and comparable evidence. Therefore, the true economic benefit of offshoring is yet to be determined.

The understanding of the true cost is also important to make informed decisions upfront. Business-cases for offshore software development are defined before the start of the collaboration, and are usually based on the expectations and hypotheses that deserve validation afterwards. When the offshore work is actually carried out and all costs emerge (expected costs and unexpected costs), only then can the bottom-line business case be calculated. Empirical data from industrial practice is crucial to shed the light on the hidden cost drivers and help understand the magnitude of these costs.

In this paper, we report the results from a case study conducted in a large international corporation. In our investigation, we focused on a particular type of offshoring – inclusion of captive offshore teams into the development of an evolving large-scale complex software product. In particular, the investigated organization expanded with people offshore to take over the work with the intention that the current onshore developers are 'freed-up' to take on new work. Our study covers the first two years of involvement of the developers in India working on customer specific features from India.

The most important contribution in this paper is the size of the impact of the extra costs on the hourly costs, in comparison with the salary-based hourly rates, and the further impact of the performance differences on the bottom-line costs. Given the case data, the transfer of work resulted in a significant bottom-line *increase* of the actual cost; despite the upfront targeted cost

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decrease. Additionally, we report a number of cost drivers that can be useful for other companies to consider, when calculating their upfront business cases of offshoring large and complex software products, and especially the costs associated with mentoring.

This paper is organized as follows. In Section II we outline existing research related to relocation of software products to an offshore site and associated cost calculations. Section III details our empirical case study and research methodology. The results of our study are available in Section IV and further discussed in Section V. After that we discuss the threats to validity for our study in Section VI. Finally, Section VII concludes the paper with a summary of the lessons learned.

II. Related Work

Offshoring has become a common vehicle for reducing cost in many fields. However, the actual economic benefits of offshoring are lately being questioned. It is not uncommon that even manufacturing companies get disillusioned after unsuccessful offshoring experiences and as a result bring the previously offshored operations back from the low-cost to the high-cost countries [6]. This is often because of poor quality, issues with delivery performance, and also because the total cost associated with operations abroad are often underestimated [6].

'Hidden', 'unexpected', 'extra' or 'invisible' costs associated with offshoring are an important topic in Information Systems research, which utilizes transaction cost economics constructs and adds a number of cost drivers in addition to the contract-based payment to the vendor [7]. A related research branch looks into the costs of reconfiguration and relocation of business tasks and activities [8]. Although the main stream research still considers offshoring a preferred instrument for cost reduction, there are studies that emphasize the importance of looking beyond the headcount and direct cost. For example, Hirschheim and Lacity [9] have found that vendors often reduced their cost on expense of service quality and performance.

Unfortunately, the number of studies that focuses on the actual cost and cost calculations in software engineering research is scarce [3]. A first attempt to reveal the actual cost of offshoring compared to in-house onshore development was published by Smite and van Solingen [10]. The study showed a large number of unexpected costs that highly impacted the business case. The two largest cost drivers appeared to be attrition (the number of developers leaving) and the learning curves of on-boarding new team members (taking 2-3 years). Especially surprising was that these two cost drivers multiply each other – the longer it takes to train on-boarded developers the higher the impact on the actual cost is when they leave. The findings suggested that direct and indirect costs were calculated coming to a better informed hourly cost number, especially when non-productive hours were included in the equation. However, this was the first investigation of a kind and involved only two teams of eight developers in two small/medium size companies. Furthermore, it employed a number of simplified indirect cost calculation strategies.

Although the cost calculation has not gained much attention in software engineering research, a number of hidden costs have been discussed in related research. In the following paragraphs, we summarize the cost drivers related to relocation of ongoing software development work to an offshore location, which is also the focus of our empirical investigation.

Relocation of software development activities from an "original" development site to an offshore site (also known as software transfers) usually follows the following phases: preparation, knowledge transfer, trial and support [11]. Existing research indicates that software transfers are associated with a number of cost factors. Knowledge transfer requires significant investment into training, which may result in up to 10 percent increase in project cost [12].

When a remote team is added to an ongoing project, this often leads to lower productivity [1], [10], [12], [13], [14], as the new team needs to climb up the learning curve. The learning process may take from 12 months [1], [12], up to three years [10], five years [14], [15] or even longer [16]. Furthermore, coordination of remote locations on a distance and knowledge transfer activities may turn out more expensive than expected [8].

At the same time, training puts extra demands on the original unit as well. Heavy overload of the staff in transfer projects may lead to additional expenses associated with hiring consultants for the mentoring job [14], [17] or involving internal experts [18], which are both rather expensive options. It is worth noting that the more complex or immature the software product, the higher is the cost associated with the relocation of project activities [12], [14].

When the software product is transferred, a number of cost drivers may occur only at a later point. This includes consequences of staff turnover [10], [12], [19], overheads of traveling and staff relocation [12], [14], different legal constraints related to work-time, organization, or participation of unions [12], and increase in maintenance cost [17].

Similarly, to the state-of-art in offshoring manufacturing, which determined that the current modeling techniques for decision-making are frequently incorrect or oversimplified [6], there are no state-of-art tools to calculate the cost benefits when offshoring software development.

III. Research Question and Methodology

In this paper, we continue to explore the bottom-line cost associated with offshoring software work. We supplement our earlier findings reported in [10] by focusing on a different large-company context. In particular, our research is driven by the following research question:

RQ: What is the bottom-line hourly cost of offshore developers, when being on-boarded in ongoing large-scale complex software product development?

We report our findings from studying the cost associated with an offshore location on-boarded into a large-scale complex software product development effort carried out at an international corporation, which we for anonymity reasons here call SwedCo. The research was conducted as an exploratory case study [20]. The case company was selected based on convenience sampling, while the studied case and scope were determined in consultation with the company, as a case suitable for studying hidden cost of on-boarding offshore teams in the context of ongoing large-scale complex legacy product development. The unit of analysis in our case study is the newly on-boarded offshore site.

In the following, we first describe the empirical background at SwedCo, then detail our data collection and analysis strategies, and finish with limitations and threats to validity.

A. Empirical Background

SwedCo is a large international company that develops a wide range of software-intensive products and solutions, including generic software products offered to an open market and complex compound systems with customised versions. The company has been globally distributed for a long time and is currently rapidly extending its operations in Asia.

To address our research question, we have selected a complex large-scale legacy software product, which is developed and maintained by a number of globally distributed teams. The product has been developed and maintained for more than 15 years. To address the growing demands for software developers and to implement customer-specific features for local customers (the focus of our study), SwedCo on-boarded a number of teams in secondary locations. At the moment of our investigation, there were already two such locations in Europe, one in USA, and one in India.

The work in the studied case was performed by agile teams, which might be formed specifically for completion of the given feature, and supervised by a group of senior developers and architects performing quality control functions. Depending on the competence and experience of the team members, the teams can perform more or fewer functions, for example, mature teams are allowed to perform design work and conduct code reviews independently, while newly on-boarded teams heavily depend on the support from the senior developers and architects. At the time of the study, there were up to 15 senior developers and architects supporting 24 development teams involved in the product, of which 10 teams are located in India.

A new offshore location in India was on-boarded recently both to gain flexibility in scaling the development capacity and reduce the overall development costs. Due to the changing priorities, it was decided to transfer the full responsibility for the studied product to the new site in India within 2-3 years. As a result, the primary location was to discontinue its involvement, while the other secondary sites would remain dependent on the new site. The choice of India over the other sites with longer engagement was motivated by the ease of hiring and the large salary differences.

In our investigation, we focus on calculating the cost associated with the recently on-boarded offshore location in India, and one specific type of work tasks – customer specific features (CSFs). We selected the Indian location not only because it was selected as the future leading location, but also because it had the lowest salary-based hourly rate in comparison with the other sites. Moreover, we could collect the performance data from the inception of the Indian teams, which is of higher reliability than in other locations. We chose CSF tasks mainly because it was the only task type for which we were able to track team performance in a reliable way. Furthermore, customer specific features were the main focus of the newly on-boarded Indian teams. Finally, similarly to backlog features and maintenance tasks, CSFs were equally challenging tasks for the immature teams, because they involved the need to orient oneself in a large amount of complex legacy code.

B. Data Collection

To answer our research question, we collected the cost and performance data from different sources (see Table 1). To portray the **direct extra cost** associated with the studied teams, we have gathered both quantitative data from corporate databases and qualitative estimates through one focus group and one group interview, which covered the time period of the first two years starting with the inception of the Indian teams. The **quantitative data** included reports of cost associated with the transfer, reported average salary data for the studied sites and the number of reported working hours, while the **qualitative data** included expert-based cost drivers reported in a focus group and the offshore site perspective through a group interview. We specifically looked at the extra cost drivers, which are the hidden or unanticipated costs after implementation of the offshoring strategy (Larsen et al., 2012).

TABLE I. COLLECTED COST DATA

	Cost unit	Data source
Direct cost	Salary-based hourly rate	Salary data
	Cost of knowledge transfer	Time reports
	Travel cost	Reported cost
	Cost of extra office space	Seating cost, reserved seats
	Documentation cost	Focus group estimate
	Travel administration cost	Focus group estimate
	Control cost	Focus group estimate, Time reports
	Extra hardware cost	Focus group estimate
	Planning overhead	Focus group estimate
	Managerial overhead	Focus group estimate
Indirect cost	Cost of low performance	Time reports, Complexity estimates

Direct cost, quantitative data: The quantitative data was collected from the corporate databases at various occasions between during the second year after onboarding the Indian site. The data included salary figures for Year 2 averaged per site, salary inflation rates between Year 1 and Year 2, and access to time reports for different activities and tasks within these two years.

Direct cost, estimates: After the quantitative data was collected, we organized a 2,5h long focus group to verify the findings from analyzing the quantitative information and obtain the cost drivers that were not uncovered by the quantitative data collection. We opted for focus groups instead of interviews, because this allows participants to build on the responses of others and leads to ideas that might not emerge during individual interviews [21]. We involved seven representatives from the Swedish site, responsible for managing, mentoring and steering the studied offshore teams.

To obtain the offshore site perspective, we performed a group interview with representatives from the offshore teams. Our purpose was to identify the challenges the offshore teams face when learning and acquiring the knowledge required to perform their work in the product, i.e. to climb up the learning curve. The group interview involved five developers from the offshore site and took about 1,5h.

Both the focus group and the group interview were held in person in Sweden and conducted in English. One of the researchers documented the results of the focus group in an Excel file with the cost data, which was visible to the participants during the session. The results of the group interview were documented in a Word document that was discussed with the participants at the end of the session.

Performance data was collected in three steps. First, we extracted the effort reported by the offshore teams against all customer specific features completed during the two-year period covered in this investigation (24 CSFs in total). We extracted the same data for 10 CSFs carried out by mature teams located in other locations, which were used as the baseline in this study. These were the only CSFs completed by mature teams during the investigation period. Second, we conducted a number of group sessions with senior developers and architects to measure the complexity of all CSFs using a planning poker based approach presented in [22]. Finally, we used the gathered data to calculate the productivity with which each feature was carried out.

C. Data Analysis

Data analysis started with a comparison of single cost drivers emerging from the quantitative and qualitative data analysis, and aggregating similar drivers under common categories. As a result, the cost drivers were classified as direct and indirect cost, while the direct cost were further grouped as transfer-related, distance-related or immaturity-related.

All cost calculations were processed in an Excel sheet and targeted the calculation of an hourly cost. Therefore, the discovered yearly cost was divided by the number of teams, the number of individuals in a team and the number of working hours in a year. Similarly, team-related yearly cost was divided by the number of team members and the number of working hours in a year. And so forth.

We started with the salary-based hourly rate and then included all direct cost drivers, arriving at an hourly cost that includes the extra cost (see equation 1). Finally, the bottom-line cost was expressed as the cost per 100 complexity points, i.e. the measurement unit used in the analysis of the work items (see equation 2). Notably, the bottom-line cost is a relative measure and not an absolute cost, in which we compare the performance of the recently on-boarded site during year 1 and year 2 of their engagement and the average performance of the mature sites during both years.

(1) Resulting hourly cost = Salary-based hourly rate + Extra cost per year per employee per hour

(2) Bottom-line costs per 100 work units = Resulting hourly cost / Number of work units per 10 hours

In the first iteration, all costs were expressed in Swedish crowns (SEK). However, due to confidentiality reasons, we were prohibited to disclose the actual cost. Hence, we translated the cost into a fictional currency called Galleons. To arrive at the cost in Galleon, we applied an exchange rate to all direct costs and hourly rates. We believe that this does not impact the main results, as our findings are related to the proportions and not the actual cost per se.

Our data analysis strategy aimed at methodological triangulation as prescribed by the case study methodology [20]. As a part of this process, the quantitative cost data was discussed with onshore and offshore personnel. Disagreements between the data and expert-based estimates were investigated. For example, we have compared the task complexity estimates with lines of code and the actual effort. Our cost calculations were also verified by the onshore representatives from the company during the focus group and also after the final calculations were ready.

IV. Results

In this section, we start by describing the on-boarding process and work performed by the Indian teams in the first two years. We continue with the list of cost drivers and the results of our cost calculations. In particular, we show how the cost drivers impact the resulting hourly cost of the newly on-boarded offshore teams. Finally, we present the bottom-line cost per work item and compare the costs performed by mature teams and the on-boarded offshore teams.

A. Transfer of Customer Specific Features

The transfer process started with on-boarding two teams in India, followed by the on-boarding of one team in half year later and two more teams in the beginning of the second year (see Fig. 1). The on-boarded teams went through a fast ramp-up during the period covered in this investigation, which reflected in the composition of the teams changing a lot during this period.

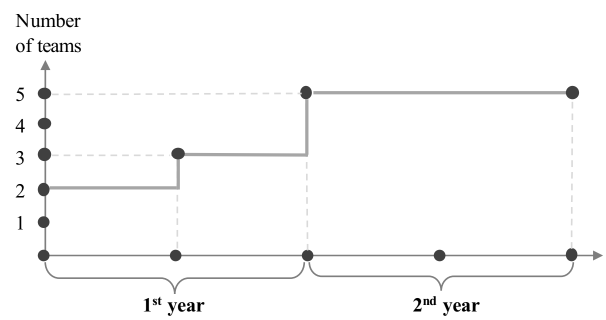

Fig. 1. An overview of the on-boarded CSF teams in India

A large part of the learning process for the on-boarded teams was based on hands-on practical work. However, before starting the work, the teams also received a three-month long training about the product, which was based on a combination of classroom training and hands-on training tasks with full time support from the trainers. The first two on-boarded teams were trained and mentored onsite in Sweden in the first half year. For the next 4 months the on-boarded teams continued to be mentored by two senior developers from Sweden locally onsite in India. In the second year, the Indian teams received mainly remote mentoring with occasional temporary onsite training in Sweden or in India (from one week up to a month in duration), which was organized to fill the identified knowledge gaps.

In the second year, in parallel with the knowledge build up, the Indian site created and maintained a number of supporting roles, the representatives of which started their work in the product in parallel with the primary site. It was the company intention to transfer full responsibility for the product to India. However, due to the size and complexity of the product, it was decided to retain the overall responsibility and the key quality control functions in the primary location at least during the first three years of the transfer. Our investigation covers the first two years of the transfer period.

B. *Cost Drivers*

In this section, we present our calculations and resulting hourly cost. All cost drivers are grouped into transfer-related cost, distance-related cost, and immaturity-related cost, as summarized in Table II. In this table, we have detailed our calculations, using configuation values from Table III to keep the formulas clear and concise. Note that we have distinguished between different years in the calculations, if the calculations were different (added the year in the parantheses), and kept the formulas generic, if there are no differences between the years.

TABLE II. DIRECT YEARLY COST PER YEAR PER PERSON

	Cost unit	**Cost per person in Galleons**		**Calculations**	**Where do the cost occur**
		Year 1	**Year 2**		
	Salary-based hourly rates	**100**	**112**		
	Salary-based yearly cost	**189 300**	**212 016**	IND-YEAR-HOURS * IND-H-RATE	
Transfer	Knowledge transfer cost	244 147		3 967 386 Galleons / (CSF-TEAMS(Year 1) * TEAM-MEMBERS(Year 1))	Developers in the primary location
	Travel cost	145 281		2 360 818 Galleons / (CSF-TEAMS(Year 1) * TEAM-MEMBERS(Year 1))	–
	Cost for extra office space	31	9	(20 Galleons * 20 seats + 20 Galleons * 5 seats) / (CSF-TEAMS (Year 1) * TEAM-MEMBERS(Year 1)) + 40 Galleons * 5 seats / (CSF-TEAMS*Year 2) * TEAM-MEMBERS (Year 2))	–
	Cost of process documentation	6 769		SWE-H-RATE * 40 hours * 11 weeks / (ALL-TEAMS(Year 1) * TEAM-MEMBERS(Year 1))	Test lead in the primary location
Distance	Administration cost	1 600	943	SWE-H-RATE * 2 hour * 52 weeks / (ALL-TEAMS * TEAM-MEMBERS)	HRM personnel
Immaturity	Cost of quality control: follow-up on process adherence	3 200	4 715	SWE-H-RATE * 1 hour * 52 weeks / TEAM-MEMBERS	Release management personnel in the primary location
	Cost of quality control: code reviews and consultation	68 905	50 202	7% * SWE-ARC-H-RATE(Year 1) * IND-YEAR-HOURS(Year 1) + 5%*SWE-ARC-H-RATE(Year 2)*IND-YEAR-HOURS(Year 2)	Senior developers and architects in the primary location
	Cost of quality control: verification of the work outcomes	1 600	943	2 * 1 hour * 52 weeks * SWE-H-RATE / (ALL-TEAMS * TEAM-MEMBERS)	Testing team in the primary location
	Rescue cost	5 376	1 367	168 hours * SWE-ARC-H-RATE(Year 1) / (CSF-TEAMS (Year 1) * TEAM-MEMBERS(Year 1)) + 58 hours * SWE-ARC-H-RATE(Year 2) / (CSF-TEAMS(Year 2) * TEAM-MEMBERS(Year 2))	Rekease architects in the primary location
	Cost of hardware for testing	14 769	21 333	8000 Galleons * 12 months / TEAM-MEMBERS	Direct cost
	Planning overhead: workflow replanning	5 231	7 707	85 hours * SWE-H-RATE / TEAM-MEMBERS	Release manager in the primary location
	Planning overhead: release replanning	1 182	870	48 hours * 8 yearly occasions * SWE-H-RATE / (CSF-TEAMS * TEAM-MEMBERS)	Release management personnel in the primary location
	Managerial overhead	3 200	4 715	1 hour * 52 weeks * SWE-H-RATE / TEAM-MEMBERS	Release manager in the primary location
	Total extra cost	**501 291**	**93 040**		
	Resulting hourly cost	**365**	**161**		

TABLE III. CONFIGURATION VALUES

Characteristic	Year 1	Year 2
Number of customer specific feature teams | CSF-TEAMS	2,5	5
Total number of teams on average | ALL-TEAMS	6	10
Average number of people in a team | TEAM-MEMBERS	6,5	4,5
Number of working hours in India | IND-YEAR-HOURS	1893	1893
Number of working hours in Sweden | SWE-YEAR-HOUR	1640	1640
Hourly rate for an Indian developer | IND-H-RATE	100	112
Hourly rate for a Swedish developer | SWE-H-RATE	400	408
Hourly rate for a Swedish architect | SWE-ARC-H-RATE	520	530

Note that for the comparison, we benchmark the Indian salary-based hourly rates against the Swedish ones, and not the average from all locations with mature teams. The working hours in Table III for Year 1 and 2 are equal, because these are the standard working hours used by SwedCo for planning purposes. In practice, the working hours every year may differ due to vacation days, but too insignificantly to account for (by less than 1 percent).

In summary, our results suggest that the inclusion of the hidden cost strongly increases the hourly cost, especially in the first year. The starting hourly rate of 100 Galleons per hour in India in Year 1 transformed into 365 Galleons per hour. The starting hourly rate of 112 Galleons per hour in Year 2 transformed into 161 Galleons per hour. In other words, the extra cost increased the hourly cost by 265 percent in the first year and by almost 50 percent in the second year. In the following sub-sections, we report the different cost drivers.

1) Transfer-Related Cost

Cost drivers related to the transfer of the work to the newly on-boarded site in India included the following cost:

- **Cost of knowledge transfer**, i.e. the cost of Swedish personnel performing the transfer of product and process knowledge to the two initially recruited teams during the first half year of collaboration, and continuing with the three teams in the second half of the first year, which was equal to 3 967 386 Galleons;
- **Travel cost**, i.e. the cost of bringing the initially recruited Indian teams to Sweden during the knowledge transfer, equal to 2 360 818 Galleons;
- **Cost of extra office space**, i.e. the seats reserved for the onsite visitors from the Indian office, including both developers and other personnel, which were equal to 20 seats for the first half year, during the knowledge transfer, and 5 seats onwards at the cost of 39 Galleons per year, split between the involved teams in each year;
- **Cost of process documentation**, i.e. the cost of producing process documentation that covers delivery and release processes, improvements of code conventions and detailing the code review process description for the recently on-boarded Indian site, which was otherwise unnecessary. The documentation was produced at the cost of two full time person months in Year 1 and is split among all six teams recruited in the beginning of the transfer.

2) Distance-Related Cost

We have also identified one factor that we attributed to distance, i.e. the distribution of roles and responsibilities in the primary development location (Sweden) and secondary remote locations (in Europe, USA, and India), in particular:

- **Administration cost**, i.e. the cost of booking trips, organizing visas, and other travel arrangements, at the cost of 1h per week for an onsite administrator and a global administrator, split among all Indian teams. This cost goes beyond the transfer duration and can be attributed to the whole period of operating in a distributed setting.

3) Immaturity-Related Cost

The vast majority of the cost drivers could be attributed directly or at least strongly associated with the immaturity of the newly on-boarded Indian teams, and included:

- **Cost of quality control**, i.e. the cost of external code reviews and consultations conducted by the software architects, thorough testing and verification of the work items, and follow up on process adherence, which was a compound architect team's effort of 7h per 100 development hours in Year 1 and 5h per 100 development hours in Year 2 according to the analysis of support effort reports towards completed customer specific features; two testing engineers spending on average 1h per week towards all Indian teams; and release management personnel spending 1h per week per team.
- **Rescue cost**, i.e. the cost of the release architect team's "fire-fighting" effort to save the critical deliveries, when the newly on-boarded offshore teams cannot fulfill their commitments, equal to 168h reported in Year 1 and 68h reported in Year 2 for all CSF teams. Note that this is only a part of the total "fire-fighting" effort spent by the architects, the other parts of which are covered in the costs of quality control.
- **Extra hardware cost**, i.e. the additional cost of reserved testing hardware estimated as around 8 000 Galleons per month per team in comparison with the mature teams. This is mainly because the newly on-boarded teams were said to use the hardware longer and more often, because of the lacking experience and insecurity.
- **Planning overhead**, i.e. the cost of re-planning the workflow due to late notice of schedule slips, which was estimated to be equivalent to five hours of planning effort per team every three weeks, or the total of 85h per year; and additional cost of replanning the releases, which was estimated to be equivalent to six person-days or 48 hours, eight times per year, split between CSF teams.
- **Managerial overhead**, i.e. the cost of consultation, approval and hand-shaking of all decisions made locally by the Indian teams, estimated to be equal to one hour per week per team. Interestingly, several onshore experts expressed their confusion about the approval seeking behavior of the offshore developers. At the same time, the offshore developers were confused about the responsibility split between the two locations and necessity to encore their work results. The on-boarded Indian teams were said to contact the

onshore personnel with a large number of questions, which were very basic in nature. As one of the participants said: "*They are willing that we "hold their hand" and require to double-check and even triple-check all their outcomes. Even after the responsibility is transferred for several roles*". The onshore personnel suspected that one reason for this behavior is that the offshore developers wanted to avoid being blamed for potential mistakes, for a similar reason as not reporting the problems early. Another reason could be that the final call about key decisions regarding the product still laid in Sweden by the time we conducted our investigation. One of the developers from the Indian site said: "*I believe that if we had more responsibility here in India, the things would be easier for us, especially because it would be easier to coordinate everything. Nowadays, we always have to talk to the architects in Sweden, which may make us wait for half a day to get some feedback.*"

C. Hourly Rates versus Bottom-Line Hourly Cost

In addition to direct costs, a fair comparison of development cost in different locations requires value consideration. In other words, it is not only important to know how much you pay per hour, but also to understand what do you receive in return. To do so, we propose to calculate the cost per unit of work. Our performance measurement is based on complexity points (CP), and thus our bottom-line cost is also expressed in the cost per CP. To ease the comprehension, we use performance measured in terms of CP per 1000 hours and the cost per 100 CPs. This can be used to calculate how much it would cost to produce a certain customer specific feature, if knowing how complex it is.

To arrive at a cost per 100 complexity points, we have first calculated performance in terms of complexity points per 1000 hours, and then calculated the bottom-line cost using the resulting hourly cost (after inclusion of the extra cost drivers).

TABLE IV. CALCULATION OF BOTTOM-LINE COST PER COMPLEXITY POINT

Category	Indian teams		Average (Year 1-2)	
	Year 1	Year 2	Indian teams	Swedish teams
Salary-based hourly rates	100 G/h	112 G/h	106 G/h	404 G/h
Hourly cost incl. extra cost	365 G/h	161 G/h	263 G/h	–
Performance: CP per 1000 hours	25,81	24,51	25,16	92,12
Cost per 100 CP	141	66	105	44

In the following, we compare the bottom-line costs in India versus Sweden. Even though we compare performance of the Indian teams with mature teams from all experienced locations, we collected the salary-based data only from India and Sweden.

Our results suggest that even though the salary-based hourly rates in India are four times lower than those in Sweden and 1,5 times lower after considering the extra cost drivers, further consideration of the "value for money", i.e. the cost per 100 complexity points, makes a dramatic difference. When comparing the performance of the recently on-boarded teams in India and mature teams in the other sites, we found that mature teams were approximately three times more productive than the immature teams. As a result, our findings show that the bottom-line development cost per work unit in the new offshore location after the first two years was almost 60 percent higher than that for the mature teams in the high-cost location.

Notably, the performance figures between the first two years in India indicate that there was a small decrease in performance, while one would expect a productivity increase because knowledge and experience have been build up in the first year. The reasons for this are twofold. Firstly, the discontinuation of onsite mentoring and support by the software architects made the Indian teams less secure and could potentially have an impact on the efficiency of knowledge acquisition. Secondly, and perhaps more importantly, this could be related to the turnover of the employees:

- A number of developers that have built the knowledge were promoted to other roles working in the same product, but not doing any development in the teams anymore;
- A number of developers left to work in other products or in another company. Attrition levels in both years are above 30 percent;
- New developers were added to increase the capacity, however in practice have partially become a compensation for the employee changes. At the end of Year 2, the number of teams doubled, while at the same time the overall productivity has decreased.

V. Discussion

In this paper, we have calculated the bottom-line hourly cost of offshore developers recently on-boarded in an ongoing large-scale complex software product development at SwedCo, and compared these with mature teams in Sweden. We found that the surface economic benefits promised by the salary-based cost comparison vanish after adding the extra cost drivers and considering the productivity gaps. Our results are consonant with a number of studies that argue that companies often fail to achieve the expected cost benefits of offshoring, because they overlook the hidden costs of implementing the offshoring strategy [1], [7], [10], especially when the complexity of the tasks and organizational setup (the number of remote sites and development teams) is high [8].

Our calculations do, however, indicate that the impact of hidden costs on the resulting hourly cost still makes the offshore location cheaper per hour. But when we also include the indirect cost associated with performance gaps this further impacts the bottom-line costs, as also found in [10]. In the SwedCo case, we found that in the second year, the offshore location is still 50% more expensive. This raises the obvious question whether SwedCo can break even in the coming years.

To answer this question, we modeled a cost prediction, based on a number of hypothetical scenarios. We considered that the breakeven point will be achieved when the offshore bottom-line cost will reach the bottom-line cost of the mature teams in Sweden. Our prediction covers a five-year period, since many related studies suggest that five years is what it takes to climb a learning curve (e.g. [14], and [15]). We have followed a two-step approach. First we calculated the resulting hourly costs, and then we calculated the bottom-line costs.

We developed one scenario for the direct cost to calculate the resulting hourly cost for the five-year period (see Table V).

TABLE V. PREDICTION FOR THE RESULTING HOURLY COST DEVELOPMENT

Cost unit	Cost per person in Galleons				
	Year 1-2	Year 3	Year 4	Year 5	*Year 1-5*
Salary-based hourly rate	106	125	140	157	***127***
Transfer-related cost					
Knowledge transfer cost	244 147	–	–	–	***244 147***
Travel cost	145 281	–	–	–	***145 281***
Cost for extra office space	40	–	–	–	***40***
Cost of process documentation	6 769	–	–	–	***6 769***
Distance-related cost					
Administration cost	2 543				***2 543***
Immaturity-related cost					
Cost of quality control: follow-up on process adherence	7 915	–	–		***7 915***
Cost of quality control: code reviews and consultation	118 123	52 210	10 338	6 153	***146 921***
Cost of quality control: verification of the work outcomes	1 271	–	–	–	***1 271***
Rescue cost	3 489	202	89	45	***7 316***
Cost of hardware for testing	36 103	21 333	21 333	21 333	***100 103***
Systemic cost					
Planning overhead: workflow replanning	12 937	–	–	–	***12 937***
Planning overhead: release replanning	1 026	–	–	–	***1 026***
Managerial overhead	3 957	–	–	–	***3 957***
Total direct cost	**291 801**	**73 746**	**31 760**	**27 532**	***721 114***
Resulting hourly cost	**263**	**164**	**157**	**171**	***204***

In our prediction, we followed SwedCo's intentions, and made the following assumptions:

- The responsibility for customer specific feature work and other areas is fully transferred to India after Year 3, and there is no need for extra travel and visa administration;
- Indian teams become accustomed with the processes and thus the need to follow-up on process adherence and verification of the work outcomes diminished;
- Indian teams continue receiving architect support from Sweden during Year 3 and from local architects from Year 4 onwards, but the amount of support needed decreases at the same rate, as between Year 1 and Year 2 (i.e. by roughly 30 percent for code reviews and mentoring, and by 60 percent for rescue support);
- The cost of hardware for testing remains, since the teams are not making a huge productivity increase;
- Governance becomes concentrated locally and the teams become more independent, thus the decision-making becomes more efficient and does not consume a lot of time. This means that there is no significant planning or managerial overhead;
- Salary inflation in India remains at the rate of twelve percent;
- Development teams do not grow (4-5 people in a team) and the number of teams stays the same;
- Employee turnover in India remains the same.

The prediction suggests that the resulting hourly cost after including the extra costs, as expected continues decreasing in Years 3-4. However, the high inflation catches up and the resulting hourly cost starts to grow in Year 5. While SwedCo might want to keep the salary inflation down and control the salary-based hourly rates, this is likely to result in higher attrition (employees leaving the company), and subsequently increase the performance gaps, and the bottom-line costs.

After the prediction of the resulting hourly costs, we created several scenarios for predicting performance development (see Fig. 2). Unfortunately, our performance data for Years 1-2 was insufficient to calculate the learning rate and construct the learning curve for the Indian teams. As such, our performance development scenarios are still merely hypothetical:

- **Scenario 0** is based on the assumption that the performance of the Indian teams for Year 3-5 will remain on the same level as the average of the first two years.
- **Scenario 1** prescribes that performance in Year 3 will remain the same as in Year 1-2 (27 percent of the mature team performance), and then increase and reach 50 percent of the mature site performance in Year 4, and remain the same in Year 5.
- **Scenario 2** is more optimistic and prescribes that, while performance in Year 3 will remain the same as in Year 1-2, it will continuously grow and reach 50 percent of the mature site performance in Year 4 and 75 percent of the mature team performance in Year 5. We intentionally leave a gap in performance after 5 years, since some studies suggest that the new developers taking over legacy projects might never reach the 100 percent performance level [1], [15].
- **Scenario 3** is the most optimistic scenario, in which performance of the Indian teams increases linearly from year 3 onwards and reaches the mature team performance level in year 5.

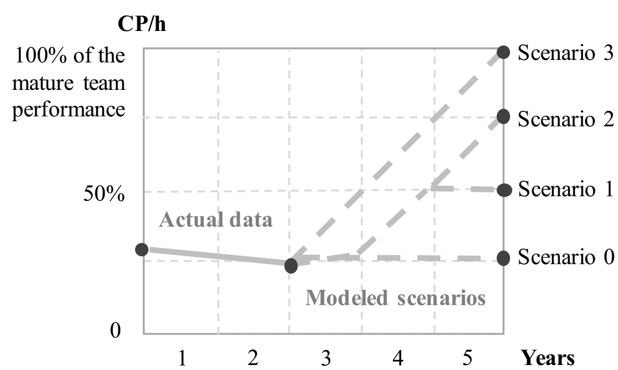

Fig. 2. Prediction for performance development

TABLE VI. PREDICTION OF THE BOTTOM-LINE COST

Category	Yearly costs for the Indian teams				5-year period	
	Year 1-2	Year 3	Year 4	Year 5	Indian teams	Swedish teams
Hourly cost (Galleons per hour)	263	164	157	171	204	416
Scenario 0	25,16	25,16	25,16	25,16	25,16	92,12
Cost per 100 CP	**104**	**65**	**62**	**68**	**81**	45
Scenario 1	25,16	25,16	46,06	46,06	33,52	92,12
Cost per 100 CP	**104**	**65**	**34**	**37**	**61**	45
Scenario 2	25,16	25,16	46,06	69,09	41,37	92,12
Cost per 100 CP	**104**	**65**	**34**	**25**	**49**	45
Scenario 3	25,16	46,06	69,09	92,12	58,00	92,12
Cost per 100 CP	**104**	**36**	**23**	**19**	**35**	45

In Table VI, we present the bottom-line cost prediction for each of the four performance development scenarios. The first row presents the projection of the average hourly rates. The rates for India come from Table V, while the average five-year rate for Sweden is based on the hourly rate in Year 1 and the annual inflation of two percent. The scenario rows contain the predicted performance in terms of complexity points per 1000 hours. For the ease of comparison, we repeat the average performance of the mature teams in the last column.

In Scenarios 1-2 the Indian teams become cheaper per hour from the fourth year onwards; in Scenario 3 this happens already in the third year. As companies tend to write off transfer efforts already completely in the first year, their internal numbers will be positive in the later years. However, our results indicate that SwedCo will break even, for the total five year period, only if fulfilling Scenario 3, which seems also to be the least realistic one. In our view, it is more likely that the performance of the Indian teams will follow the more pessimistic scenarios (Scenario 0 or 1), because of the impact of internal and external attrition on performance as suggested by our earlier work [10]. Besides, we have no indications that the performance of the Indian teams will move up rigorously; our current data did not show an upward trend. The performance might even decrease after the disconnect from the original developers as suggested in [14], [23], and [24]. Also, we have not included the cost of quality decrease associated with software transfers, which might be another cost factor.

However, the main reason to transfer the work to India at SwedCo was not done for a cost reduction reason but to free up local employees for new developments. Solely focusing on cost only is as such also limited. We could have added the profits of the freed-up local employees into the equation too, but that would make the whole calculation even more ambiguous and hypothetical.

VI. LIMITATIONS AND THREATS TO VALIDITY

In this section, we discuss the validity threats and limitations associated with our work using the classification by Runeson and Höst [20].

Reliability threats are related to the repeatability of a study, i.e. how dependent are the research results on the researchers who conducted it [20]. Three researchers participated in the design and execution of this investigation, mitigating this type of threat. Moreover, representatives of the company verified our observations and findings to avoid false interpretations; though the final calculations were only verified with onshore employees of SwedCo. We also designed an explicit case study protocol, following the guidelines by Runeson and Höst [20]. However, the approach used to measure some of the variables (e.g. the cost drivers) involved expert judgment, i.e. it is very hard to obtain the same values with the involvement of different people.

Internal validity threats are related to factors that the researcher is unaware of or cannot control the extent of their effect in the investigated causal relationship [20]. Cost is a construct influenced by several different confounding factors. We mitigated this threat by involving people with different roles and by using different sources of archival data, i.e. data and method triangulation. Regarding the qualitative part of our research, the main internal validity threats are investigator bias and interviewee bias. To mitigate these threats, three researchers were involved with the design of the focus group and the group interview guides (investigator triangulation). We mitigated the second threat by involving different people with different roles (data triangulation).

Construct validity threats reflect whether the measures used really represent the intended purpose of the investigation [20], in our case – the cost drivers, the resulting hourly cost and the bottom-line cost per work item. Our investigation was constrained by the data availability and therefore, our results are limited to the cost drivers obtained through the qualitative means. To mitigate this threat, we collected data using multiple methods, i.e. method triangulation, and organized a sanity check of our calculations performed by the line responsible for the product from SwedCo. When it comes to the resulting hourly cost, it is important to note that we have not included all potential overheads, since we have focused on the cost drivers and cost additional to the cost of the teams in other locations. This was also important to have a fair comparison of the bottom-line costs.

External validity threats limit the generalization of the findings of the investigation [20]. Since we employed the case study method, our findings are strongly bounded by the context of our study. In addition, the results presented in this paper are related to only one product in one company, and also contain hypothetical predictions for later years. To accommodate the judgement of the applicability of our findings, we made an attempt to detail the context of our study as much as possible, taking into account the corporate confidentiality concerns. We believe that the results reported herein can as such be of particular interest for researchers and practitioners involved in large-scale distributed software development and software transfers of complex legacy products in particular to India.

VII. CONCLUSIONS

The results of our detailed investigation of the bottom-line cost of the offshore site on-boarded in a large-scale complex software development demonstrate that mere consideration of the salary-based hourly rates in business case analysis results in significant underestimation. Our results suggest that decision-making for software transfers requires a much broader view on cost, and may never be limited to hourly-based salary cost only. Especially in large-scale complex product development, in which initial knowledge transfer and mentoring costs have a significantly large impact on the hourly costs, when transferring work to immature teams that have no knowledge of the specific product at hand.

In our case, transfer-related, distance-related and especially immaturity-related cost drivers increased the hourly costs by several times. Additionally, the performance gaps indicated that the cost per work unit is considerably cheaper when performed by mature developers with many years of experience, and locally present experts and software architects.

While we have found considerable one-time investments in the first year, our results indicate that the hidden costs diminish in the second year, and although the resulting average costs per hour after two years are higher than the salary rates, the direct costs in the offshore location become significantly lower. We have found that the return of these investments depends on i) the number of teams and ii) the years of collaboration. The higher the number of teams and the longer the years of collaboration, the better the business case.

At the same time, large performance gaps, as in our case (mature teams having a three times higher productivity after two years) mean that the return of investment is threatened. Our results indirectly support those studies suggesting that large-scale complex products with a large amount of legacy code might have a very long learning curve and as such may also need a very long time to break even.

We also modeled several hypothetical development scenarios beyond the first two years. The only scenario which will break even within five years seems to be the most unlikely one as well. However, looking from a different angle: when completely ignoring the initial investments in the first two years, only the most negative Scenario 0 will be more expensive in the fourth and fifth year; all other scenarios are positive in the fourth and fifth year. However, to reach breakeven over the full five-year period, the studied company needs to work on drastically improving performance and controlling external attrition in the coming three years. This also suggests that the product shall have at least three more years of life cycle ahead, and probably even more, when considering that the actual performance increase may be delayed.

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