



Risks and risk mitigation in global software development: A tertiary study



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ABSTRACT

Context

There is extensive interest in global software development (GSD) which has led to a large number of papers reporting on GSD. A number of systematic literature reviews (SLRs) have attempted to aggregate information from individual studies.

Objective: We wish to investigate GSD SLR research with a focus on discovering what research has been conducted in the area and to determine if the SLRs furnish appropriate risk and risk mitigation advice to provide guidance to organizations involved with GSD.

Method: We performed a broad automated search to identify GSD SLRs. Data extracted from each study included: (1) authors, their affiliation and publishing venue, (2) SLR quality, (3) research focus, (4) GSD risks, (5) risk mitigation strategies and, (6) for each SLR the number of primary studies reporting each risk and risk mitigation strategy.

Results: We found a total of 37 papers reporting 24 unique GSD SLR studies. Major GSD topics covered include: (1) organizational environment, (2) project execution, (3) project planning and control and (4) project scope and requirements. We extracted 85 risks and 77 risk mitigation advice items and categorized them under four major headings: outsourcing rationale, software development, human resources, and project management. The largest group of risks was related to project management. GSD outsourcing rationale risks ranked highest in terms of primary study support but in many cases these risks were only identified by a single SLR.

Conclusions: The focus of the GSD SLRs we identified is mapping the research rather than providing evidence-based guidance to industry. Empirical support for the majority of risks identified is moderate to low, both in terms of the number of SLRs identifying the risk, and in the number of primary studies providing empirical support. Risk mitigation advice is also limited, and empirical support for these items is low.

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1. Introduction

The aim of this research is to investigate risk and risk mitigation strategies in global software development (GSD). In order to achieve this goal we have undertaken an assessment of GSD systematic literature reviews (SLRs). An SLR is a way of synthesising existing research by following a rigorous, pre-defined procedure aimed at reducing bias. They are based on aggregating the research undertaken in other studies. The aggregated studies are referred to

as primary studies. Since it summarises the research undertaken in primary studies, a SLR is referred to as a secondary study. A systematic mapping study, or mapping study, is a form of SLR that aims to address a broader set of research questions in order to provide a 'map' of a particular topic area by investigating, for example, the number of papers published on the topic per year and where the papers are most frequently published [23]. Studies which synthesize data and information from a number of SLRs in a particular area are called tertiary studies.

This paper is an extended version of a paper previously presented at EASE 2012 [34]. While our initial investigation focused on mapping GSD SLR research and identifying active researchers and institutions, we now extend our earlier study to include the identification of GSD risks, and risk mitigation advice. As we are involved in research aiming to provide recommendations for GSD

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client organizations, we wish to discover if the SLRs we identified furnish enough risk and risk mitigation advice to provide a useful foundation for this work. If there is not enough detail we would need to perform a new SLR ourselves to achieve our ultimate research goals. We next provide a short overview of GSD, then briefly discuss GSD risks and conclude this section with our research questions.

1.1. Global software development

The software development paradigm is changing with improvements in telecommunications encouraging the increased use of GSD (also termed distributed software development (DSD), distributed software engineering (DSE) and global software engineering (GSE)). GSD is used to describe one of the following situations:

- When organizations shift all or part of their software development to another country (referred to as off shoring), to lower cost destinations, and/or to destinations where the required skills are more readily available. Such organizations are normally independent client companies who outsource their software development to a vendor or software supplier who then develops the software.
- When multinational organizations distribute their software development activities across multiple subsidiary sites, many of which are in different countries, e.g., IBM, Bosch, Siemens [3] and Phillips [24]. Here, the multinational subsidiary that requires the software can be viewed as the client and the subsidiaries that develop the software can be considered (in some ways) equivalent to software vendors.

The motivation for GSD is usually to achieve improvements in time-to-market efficiency, to obtain access to a larger number of resources at lower cost, and thus to gain and maintain competitive advantage [24]. The growth of GSD has been helped by the availability of well educated and technically competent software engineers in low cost areas such as Eastern Europe, Latin America, India and the Far East [5]. GSD growth means that many software engineers have to collaborate over geographic, temporal, cultural and linguistic distances [29]. However, the benefits associated with GSD will not be achievable unless project risks are managed throughout the life cycle of these projects.

1.2. Global software development risks

Despite the potential benefits there is no more promise of GSD success than there is for in-house development or domestic outsourcing and, in light of the additional risks incurred, GSD may be an uncertain undertaking [12,13]. In this context a risk denotes a particular aspect or property of a software development task, process, or environment, which, if it is ignored, will increase the likelihood of project failure [30]. GSD introduces risks which may not be fully understood and hence are not properly mitigated [11]. Failure to understand and manage project risks can result in significant losses, including project failure, and this may subsequently affect the achievement of an organization's business objectives [33]. Many organizations that have undertaken GSD have discovered that off shoring to distant subsidiaries or outsourcing software development to remote software vendors is neither simple nor straightforward [5]; GSD projects are often large-scale, and global development leads to significantly increased complexity. GSD complexity leads to increased risk. Offshore projects tend to be unsuccessful, because "physical, time, cultural, organizational, and stakeholder distances negatively influence communication and knowledge exchange between onshore and offshore project team members" [14]. When a software project is carried out in

multiple countries, the software development project manager must address execution risks, such as those related to project distribution, time zone differences, as well as issues related to communication, coordination and control, project context, and infrastructure [4,16,17]. In some cases organizations have found that GSD efficiency is disappointingly low with up to 50% of development effort spent on overheads such as communication and increased project management [24]. Suggestions have been made that a 50% failure rate for GSD projects is not uncommon [26].

Organizations frequently consider offshore systems development in the belief that projects can be completed at lower cost. While prices quoted by offshore vendors may be very appealing additional risks must be considered when considering offshore systems development. These risks have associated costs and typically result in additional indirect costs which add to the total payment required for the delivered system. However, such costs are seldom considered by companies at the outset of a project, yet may become painfully apparent once the project is under way [11].

All software development projects involve some degree of risk and some GSD project risks are identical to those faced by onshore developments [11]. However, as noted earlier, there are issues that need special attention in the offshore context. Building on conventional risk factors from earlier research, a survey of senior IT executives with offshore project experience [28] produced a ranking of risk factors that apply to GSD projects. Risks identified were those that (1) appeared both in on-shore and offshore projects but were exacerbated in the offshore context, and (2) those that were unique to the offshore context. Their findings suggested that the offshore context was more vulnerable to some traditional risks such as communication issues, poor change controls (scope creep), lack of business know-how, and failure to consider all costs. Communication in the offshore context can be especially risky due to the effect of language and cultural differences between the onshore client and offshore vendor: poor change control figures prominently in both contexts. What stood out in the offshore context was lack of business know-how. Client product managers found it difficult to convey to overseas vendors the business practices and competencies of a company. Factors unique to the offshore context [28] included seven risk factors specific to GSD: language barriers in project communications; cross-national cultural differences; constraints due to time-zone differences; unfamiliarity with international and foreign contract law; political instability in offshore destinations; negative impact on image of client organization; and currency fluctuations. One comment by an expert illustrated these concerns: "Doing business with a different country usually involves risks of a dispute due to different (or incompatible) laws, currency, business and accounting practices, failure of communication lines and travel, political risk, etc. Telecommunications and infrastructure issues arose because of a lack of reliable networks in some countries" [28].

To deal with the increased GSD risks the client must monitor the development closely [1,33] and an experienced project manager with an understanding of the most widespread risks can help alleviate problems before they occur. Thus the findings of our research may assist clients to recognize and understand risk factors that affect such projects, so that effective actions can be taken before the risks manifest themselves into problems that damage the project [33]. When projects go awry there can be a disinclination to investigate the real reasons, so we frequently are unable to identify which risks proved fatal. It is less embarrassing for a company to bury the project and move on, particularly if the mistakes were overarching high level management errors, e.g., without sufficient high level management support many stakeholders may not feel inclined to fully cooperate in requirements gathering [33]. Few failed projects result in litigation; of those that do, most are settled out of court and the "gag orders" imposed make it difficult to find

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