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SOFTWARE RISKS AND MITIGATION IN GLOBAL SOFTWARE DEVELOPMENT

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ABSTRACT

The Global Software Development is becoming so much complex and challengeable as the scope of the problem domain of the user increases day by day advancement. In today's modern world of engineering development, almost all projects suffer from some unwanted threats called risks which can seriously affect the quality, cost and schedule of the projects and hence could have a large negative impact on a project. Even many projects are cancelled due to catastrophic risks so it is very much important for a good project management to identify, monitor, plan and control the potential risks so that it is ensured that the project completes according to the satisfaction of all stakeholders interested in the project. The risks occur in GSD are much more different than those risks that in Local Software Development. Even sometime a tinny risk becomes a serious catastrophic risk in GSD. This paper provides some necessary information regarding the potential risks that can occur in the GSD, their consequences on the projects, and some useful guidelines of handling these risks.

Keywords: *GSD, Offshore, Outsourcing, Risks, Software Project Management,*

I. INTRODUCTION

Software risks [1, 2] are managerial issues which should be handled through proper management of the project. Only a skillful and an experience mangers associated with software project office [8] can handled these issues while a bad software manager may lead to un-controlling the risks and ultimately results in the failure of the project. Software risks should be monitored and controlled from the start phases of the project management life cycle [5]. The Global Software Development (GSD) [8, 9, 10] is becoming very difficult, complex and challenging in the context of software project management as the user problem is getting more and more challengeable. In this respect the risk management in GSD is also much complex than local software development. GSD, in particular, has some specific concerns that may not be obvious until their impact has been realized. We have seen many projects got failed because they did not pay adequate attention early enough to certain factors common in GSD projects. This research paper provides a detail list of potential risks in the GSD project and provides some useful guidelines in this respect. So the whole discussion is beneficial for both academic and industrial point of views so it is wise to have as input some concept of the risk profile for the particular organization. This paper is arranged in a very chronological order and all terms and concepts are self explanatory. The paper is arranged in these sections. Section I is obviously an introduction. Section II provides some basic terminologies about risks, risk management and Global Software Development. Section III outlines main issues in GSD. Section IV is the main section of the paper and contains a very rich discussion about risks that may occur in GSD project, how

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these risks can affect the GSD project and its possible mitigation guidelines. Section V is the conclusion and implication and contains the whole brief remarks about the risks and state that why it is important to mitigate these risks in GSD project. And in the final there is a vast list of references that are properly reviewed and referenced with permission.

II. PRELIMINARY ABOUT RISK MANAGEMENT

A. What is a Risk?

Definitions of risk in general as described by Royal
Society [1, 2]; "the probability that a particular adverse event occurs during a stated period of time, or results from a particular challenge" and based on the British Standard- 4778, as "a combination of the probability or frequency of occurrence of a defined hazard and the magnitude of the consequences of the occurrence" [3].

B. What is an IT Risk?

First it is important to consider here that by the IT risk we mean the same concept as like software risk. For the definitions of risk it seems appropriate to consider the 1995 publication of National Institute of Standards and Technology (NIST) handbook's definition which describes an IT risk as ''the possibility of something adverse happening" [4].

C. Software Risks and Spiral Model

Software risks are first time introduced in the Spiral model [5] by Mr. Berry Boehm of his series of software development life cycle models in which the possible risks are analyzed i.e. all technical and managerial risks are tried to resolve in risk analysis phase of the spiral model. Since the spiral model is an evolutionary model and one complete spiral represents a complete prototyping of the product and mostly involves more than one spiral thus it makes the risk analysis an iterative process. That means that the risk should be constantly monitored and control because it is possible that a low priority risk may become a highly dangerous in some next iterations.

D. What is Software Risk Managemnt?

Risk management [6] ensures high priority risks to be reduced to an acceptable level by applying appropriate security measures. Risk management "refers to planning, monitoring and controlling

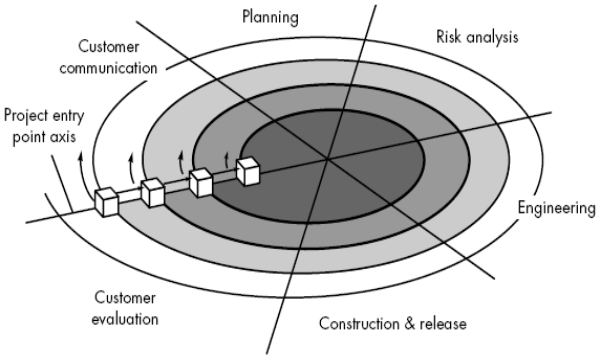

Fig.1. Spiral Model [5] of Software Development Life Model

activities which are based on information produced by risk analysis activity", where as the management of risk is described as the "overall process by which risks are analyzed and managed" [7].

E. What is Project Managemnt Office ?

The Project Management Office (PMO) [8] is the central office of where primary responsibilities are assigned of the project (or program) manager. He may be assisted by Quality Assurance (QA) or process experts, but any team member has the responsibility to identify potential risks and actions to mitigate risks. A Risk Management Plan is developed during the elaboration phase, but the plan is implemented and monitored as soon as the first risk is documented.

F. What are a potential list of risks that can occur in an IT Project ?

The following is a list containing some mostly occurring IT risks in the IT Project. This list is collected form a survey conducted at different firms and organizations functioning at Islamabad.

1) Personnel Hiring and Shortfalls
2) Unrealistic Schedules and Budgets
3) Developing the Wrong Functions and Properties
4) Developing the Wrong User Interface
5) Gold-Plating
6) User Platform Incompatibility
7) Continuing Stream of Requirements Changes
8) Shortfalls in Externally Furnished Components
9) Shortfalls in Externally Performed Tasks
10) Real-Time Performance Shortfalls
11) Straining Computer-Science Capabilities
12) Case Tools under Performance

G. *What is Global Software Development (GSD)?*

Distributed Software Development (DSD) has become a business need in the global world, and had been previously referred to as outsourcing, off-shoring, multi-site development, distributed development, and "Software Engineering over the Internet". GSD adopt the "Follow the sun rule" which means to utilize the full time for the project development. Thus GSD is also called "SUN NEVER SETS DEVELOPMENT".

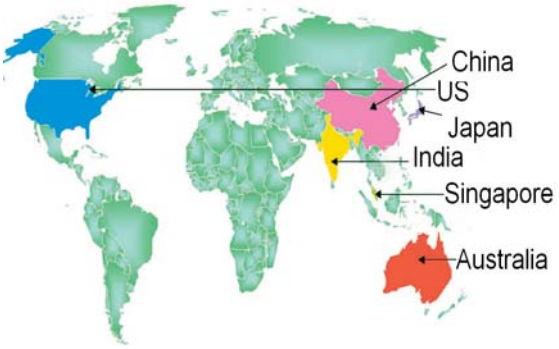

Fig.2. World Wide Development Partners

Currently, it is renamed as Global Software Development (GSD) [8, 9, 10] with the emphasis on "globalization". Global software development is the multi-faceted and coordinated activity of managing software development process across teams, partners, and organizations and even across countries. GSD has three distinct but complementary perspectives [9] towards that, as given in Figure 3.

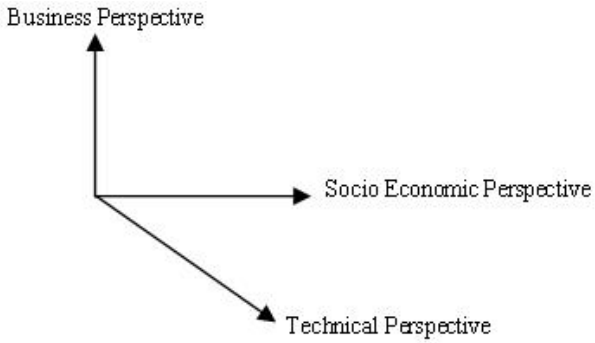

Fig.3. Perspectives of GSD [9]

Business Perspective:

GSD offers many prospects to enterprises. It decreases the total cost of ownership by parallelizing the development activities across different business units and enabling round-the-clock development.

Technical Perspective:

Actually GSD provides a setting for understanding software development in general, because common problems of coordination are naturally exposed to observation and experimentation so in several contexts, physical distance only amplifies the inherent problems in software engineering.

Socioeconomic Perspective:

Regardless of its global nature, the problem is especially important for individual software industries. As an example, developing countries such as Turkey, Romania and Ukraine may reap the benefits at two folds. First, the development effort in industrialized cities may be partially shifted to less industrialized ones but with higher IT labor force at Universities and Technology Development Zones where the demand for software is lower but the supply is more reasonable. This shift will not only reduce the costs, but also increase the growth rate in these regions. Also such countries are ideal candidates for GSD in global markets due to their highly qualified and relatively cheaper professional labor and European style of work. There exist many countries such as India, Pakistan, China, and Singapore which has the same potential in that sense.

III. ISSUES IN GSD

Global Software Development (GSD) has become a business need in the global world, but there are some about six issues [11] related with this sort of software engineering as explained in this section.

A. *Geographical Distance*

Geographical distance is a spatial distance between two entities (organizations, persons, cities, etc.) measured by the cost and times. It is also measured in ease of delocalizing and relocating and has different factors effecting for instance like the type of transportation, the time necessary for traveling from one location to another, the 'need to have a visa or other permission.

In case of GSD the geographical distance is not symmetric; at least from the geographical point of view (the distance between New York and

Islamabad is the same as between Islamabad and New York). In simple words the efforts required to cover a geographical distance between two locations can be bigger in one direction than in the other. For example, often, it was easier for a Swiss project manager to go to India than to bring a developer form India to Switzerland. Moreover, the distance between two locations depends on the transportation facilities. For example, if the offer of regular flights between two locations is significant, the distance will be considered as lower than in the situation where no offer is at all. Hence the geographical distance is becoming a vital issue in GSD.

B. Temporal Distance

The temporal distance is defined by Agerfalk et' al. [12] as a "dislocation in time, experienced by two actors wishing to interact". This includes characteristics like hours of work, execution time, response time etc but the most important is the time difference between the time zones of two locations. This difference plays a significant role and requires managing work schedules of different entities in order to increase as much as possible their overlap and therefore to facilitate the communication between distant stakeholders. For example, the temporal distance between Pakistan and Canada is bigger then between USA and Canada but can be considerably reduced if the corresponding partners accept to adapt their hours of work. Another characteristic related to the temporal distance is the time necessary for executing a task. For example, it takes more time to copy files on a distant server than on a local one. The time importance to get the response to a query from a distant partner is very much important and can slow down the productivity when the response is necessary in order to continue the work.

C. Socio-cultural Distance

Socio-cultural factors are based on the fundamental difference of the system of values that governs our lives. This is very complex and concerns different cultural aspects like organizational, business, language and political culture as well as personal motivations and work ethics. Actually a culture defines the norms, values, expression manners, communication styles and has an impact of the respect of the organization hierarchy [13]. Agerfalk et al. [12] define the socio-cultural distance as a measure of understanding and accepting the norms and values of a stakeholder by another one. The socio-cultural proximity between two people is not always reciprocal as peoples can easily accept the ways and customs of the each other.

D. Organizational Distance

GSD needs a tight synchronization of the development processes of participating teams. A great problem becomes when common processes are not understood well enough by GSD team members. Development methods used on different sites can vary and pose problems during different development phases have the impact on the quality of the obtained results [14]. For example, if one partner is in the habit to produce project documentation only in the end of the project and the other one aims to have it during the project thus the conflict can arise according its evolution.

E. Technological Distance

The difference of technological platforms used by GSD partners can induce great problems especially during the phase of tests. For instance code tested and validate on one servers can generate different results while testing at another servers. Besides, the difference of the database used for tests can also generate problems or do not allow reproducing errors obtained on different site. A good solution would be to establish a common centralized testing platform. The detail discussion can be found Bass and Paulish [15].

F. Knowledge Distance

Lack of knowledge about the solution can cause bad specification of system requirements and hence bad design of the solution. Incomplete, insufficient or unclear requirements specification can be considered by a distant partner may create some serious problems and as while locally it is considered an easy task as compared to GSD. Besides, misunderstanding problems can arise when one of the partners has insufficient knowledge about the formalism UML diagram used for the system design. Finally, a good level of knowledge and specific ability can be required for each particular task in a project. We have noticed that knowledge gaps in one of the teams can have serious consequence over the whole project. To handle this issues some constant trainings could be organized during the whole project phases so that it may be insured that the there remains the background knowledge at the same level among the staff.

IV. POTENTIAL RISKS IN GSD & THER MITIGATIONS

Here we identify the possible risks that are associated with GSD. These risks are analyzed and presented here. Whereas developing software 'in-house' results in some risks, developing it partly in another geographical location multiplies these risks exponentially. Risks management should begin early in the project phases and proceed as a monitoring and follow-up effort throughout the life cycle of the projects. Based on the risk management principle proposed by Mohtashami et al [16] and the framework of risks associated with offshore outsourcing of Kliem [17], it is very clear that in offshore software development, risks identification and management is conducted in six phases. These risks are arranged in a certain order. These risks are listed diagrammatically in the following Fig 4.

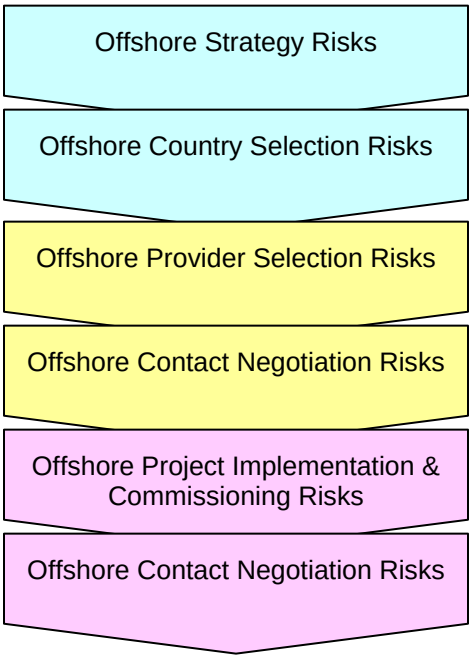

Fig.4. Potential GSD Risks

1. Offshore Stratey Risks

Offshore outsourcing strategy is the process of determining whether domestically or offshore, and if so, what to outsource? It is like make or buys decision [18, 19-22]. Subsequently there is danger that the decision will end up being made on an impromptu basis. This phase includes the following risks:

A. Unclearly Defined Goals and Objectives

This is associated with unclearly defined offshore software project goals and objectives before starting the offshore outsourcing process. The client's objectives to reduce costs are directly related to the excessive talents as well as their innovative, creative and advanced approaches [23]. This requires identifying what should be offshored, the characteristics of the project and the suitable service provider profile. For instance, service provider capabilities may be stated as having expertise in financial services and also with strong .NET skills, with between 100 and 500 personnel. Otherwise, the lack of clearly defined goals and objectives may lead to making the decision to offshore without complete information on internal domestic costs and processes which can seriously affect the project. It is worth to mention a famous statement of Cusumano [24] stated it: "Globally distributed projects (or offshore outsourcing) must involve participants with strong organizational and process skills".

B. Lack of understanding of the basic requirements of dispersed project management.

This comprises the lack of understanding the human relations, employment law and other legal requirements for an offshore outsourcing [25, 26, 27].

C. Failure to See the Broader View

Many clients fail to see the broader view [28-30] of offshore outsourcing. According to Davis et al. [31], offshoring is generally the responsibility of the chief information officer (CIO) which functions at the awareness of cultural and legal differences and of risks associated with offshoring and outsourcing in general.

D. Selecting a Wrong Project

Selecting a wrong project offshore has tremendous consequences that are amply discussed in the outsourcing/offshoring literature [32, 33, 34-38]. A framework has been proposed by

Ravichandran and Ahmed [24] to overcome this type of risk. .

E. Lack of Financial Resources and Overstated Expectations

The problem of Lack of financial resources and overstated expectations [39, 40, 41, 42] of clients and providers can threaten the software projects. In general, small and medium-sized companies have neither the financial nor the necessary human resources strength that big companies usually possess. Consequently, various projects were abandoned or stopped due to lack of finance. As Dubie [41] stated "smaller companies, in particular may lack the resources to commit to an effective long-term offshoring strategy".

F. Firm Size

Firm size is also called barrier size and is an important to both client and service provider. The size of the client firm relative to the vendor is an important variable in the outsourcing context and strongly increases client's bargaining power [43].Carmel [44] identified eight (8) success factors among which the firms and their size played an important role. According to Nooteboom [45], there is "threshold costs" in setting up a transaction with a partner (offshore service provider). However, "these threshold costs arise regardless of the size of the transaction, and thus weigh more heavily for the smaller transactions associated with smaller firms, for both suppliers and buyers". Therefore, it needs analyzing the true return on investment of an eventual offshored project before such transaction.

2. Offshore Country Selection Risks

Selecting a suitable offshore country is another critical step for successful offshore outsourcing. For this purpose a sound criteria for countries selection should be established and must be followed. It includes risks such as:

A. Country Risks.

Country risks occur due to the problems related with the possibility of shifting local political, regulatory and economic conditions [46].

B. Political Risks

The politics can also affect the offshoring for example, a political of the India/Pakistan on Kashmiri dispute created an intensified alertness of political risks of doing business in India [47- 51].

C. Host Country Laws and Regulations

These include risks such as technology transfers, intellectual property and copyrights, privacy laws, and transborder data flows can seriously affect the offshore GSD relationship [52].

D. Cultural literacy at the country and firm level

At the country level, the difference in the nature of culture may impact upon offshore outsourcing negatively [53] and similarly at the firm level, there are also different organizational culture and practices [54]. Issues such as business moral [55] and norms are dominant of these types of risks.

E. Telecommunications Infrastructure Level

Offshore outsourcing of software development may be affected due to a substandard telecommunications infrastructure [54]. Prikladnicki et al. [56] considered the telecommunications infrastructure a foundation for all the other strategies.

3. Offshore Provider Selection Risks

Different researchers pointed out that the selection of the right service provider is very important for offshore project success. The risks associated with this category include the following risks.

A. Lack of Variety of Perspectives in the Selection Process.

Michell and Fitzgerald [58] concluded from their research by stating that "vendors are clearly not all alike and, the vendor selection process must match not only 'hard' track record, financial stability, quality and capability requirements, but also understand the 'softer' issues of vendor vision, culture, background and human resource management issues".

B. A Lengthy & Expensive Service Selection Process

The service provider selection process can be lengthy and expensive. Making a faster personal decision rather than a thorough commercial decision may lead to disastrous result. A good selection process involves costs, such as [59], documenting requirements, sending out RFPs, evaluating the responses, and negotiating a contract.

C. Poorly developed and documented service or product specifications

Specifications are erroneously written in the same way they are for developing software in-house. Offshore software development requires clear, very detailed written specifications. The Overby [59] stated that "The ability to write clear specifications is also critical to achieving offshore savings".

4. Offshore contract negotiation risks

The offshore outsourcing contract is helps in effective partnership. Bryson and Ngwenyama [60], state that "Key to managing outsourcing relationships is the outsourcing contract". The difference between successful outsourcing and a disaster may simply be determined by the selection of a suitable provider and the terms of the contract. A good contract, communication, coordination and cooperation between all parties build trust and reduce uncertainty for the outsourcing client. The following are the risks associated with this issue.

A. Understanding Different Types Of Offshore Contracts

Applicability and determining suitability of buyer/seller versus strategic partnerships to the project is very much crucial. Strategic partnerships are primarily about relationships. Buyer/seller arrangements are mostly about contracts, not relationships. Though the characteristics of each type of contract are different but they can be combined to establish both relationships to be specific contracts in offshore outsourcing. The following risks come under this category.

B. Service Level Agreements (SLA)

The SLA defines the functions that the service provider team will commit to during the engagement, assigns priorities to these functions, and establishes baseline service standards and commitments [61]. According to Cusumano [24], a great hardship occur and it is easy to loose money on fixed price contracts in case work runs out of control or the initial estimation was poorly conducted. Therefore, Cusumano [24] recommends to service provider to "persuade the customer to agree to an initial scoping and prototyping engagement lasting from a few days to a few weeks, depending on the size or complexity of the task". This results in much enhanced estimate of cost of the time needed.

C. Be Cautious About Vendor's Standard Contract

It is important to be careful in contract negotiation because each party tries to protect themselves as much as possible. The best technique is to use own standard contract clauses. Offshore service providers often also have an officially standard contract to speed up the negotiation process. The disadvantage of this contract is that they favor the vendor and not usually include any performance standards or penalty clauses [62]. A close supervision is helpful to a firm to be careful in the case of any deficiencies in its agreement and ensures that its money is wisely spent in the right way.

D. Security and privacy

Offshore outsourcing increases the security and privacy risks because the client firm has no total control over the project. So the additional supervision is required for intellectual property risks such as patent, copyrights and trade secrets. For example, Ahmed [63] reported greatly publicized security breaches and fraud in Indian call centers. So it may conclude that there is great deal of security problems in software development firms.

5. Offshore Outsourcing Implementation and Commissioning Risks

The project implementation and commissioning has some catastrophic risks and usually starts with the 'education' and integration of the offshore outsourcing client's commissioning team and offshore service provider's team with the goal and procedure of project implementation and commissioning [64]. It includes the following risks.

A. Poor implementation and commissioning planning

The poor implementation and commissioning planning is with respect to time of transition to service provider and the transition period is actually the expensive stage [46] and is from three months to three years [65, 59], depending on the project size, to completely handing over the work to an offshore service provider. It is during this step that knowledge is transferred from client firm employees to members of the offshore team but it needs additional costs to offshore projects. Offshore outsourcing implementation is necessary because the relationship between the client and service provider is defined and established.

B. Transition risk and cost.

Transition risk and cost can be reduced if the buyer and supplier have compatible methodologies. Subsequent research in offshore project management identified the need to establish and monitor performance standards, support the transition processes, flexibility, and mutual governance mechanisms in outsourced projects [21, 66].

C. Unresolved Operational Issues in the Service Agreement before Moving To the Legal Aspects of the Agreement.

There two important advantages of clear service agreement. First includes 1) Expectation - it makes feasible to avoid and fix the rising level of client's undocumented expectations, 2) cost control – the SLA enables better determination of the appropriate level of service needed, 3) productivity – the SLA provides a platform to both client and service provider to measure the productivity and service quality improvements. Second, the service provider uses SLA information to determine its costs and staff hiring requirements to meet those service levels.

D. Inadequate Planning of Information Systems and Interfacing With The Service Provider

There is one cause of failure in offshore outsourcing resides in the heterogeneity of the information systems of both client and the service provider. A proper preparation and alignment of both systems is the key to resolve this risk.

E. No training on company product line or service expectations

As stated earlier domain knowledge is the largest challenge faced by offshore outsourcing service providers. The domain knowledge provides the great honor to the company as it increases the scope of the company. Tiwana [67] says about this problem that "The knowledge is distributed on either side of the client vendor boundary. In an outsourced application development project, the client organization maintains knowledge about the project's business needs and the vendor organization maintains technical expertise to develop the software". In the same way , Hanna and Daim [68] stated that "Client and vendor must have the right mix of competencies and know-how". In short, to achieve success, the client firm must transfer domain specific knowledge to the service provider through training. Rottman [69] advised that for the offshoring , the client organization has to train the service provider employees in fairly better way.

F. Lack of detailed understanding of the project sends to offshore

Quite often, various client firms think that offshore outsourcing is a panacea for all software development projects. Research has proven that it is one source of many failures of various systems development projects in the lack of understanding of the very nature of the project [70].

G. Unrealistic Timeline

An improbable timeline for any of the outsource/offshore process can lead to disappointing results and ultimately fail the project.

6. Offshore Management Risks

Managing an offshore outsourcing project is complex [11,14, 111] and demanding in terms of strong skillful, experienced and technical management input. The manageability of the offshore project, the relationship and the development efforts required impose greater risks. This starts at the very early stages with the client not being adequately prepared to do business offshore.

A. Lack of Full Communication Plan

A full communication plan means effect including escalation processes, regularly scheduled meetings, review periods, and employee communication. According to Pfeffer [71], "Conflict is largely the result of misunderstanding, and if people only had more communication, more tolerance, and more patience, many (or all) social problems would disappear". Also, Christiansen [72] claims that "communication is of such importance, that if it is not taken seriously in the offshore project, all the advantages of offshore development, such as access to talent, greater flexibility in access to resources and cheaper resources will be lost in the informational overhead".

B. No full impact of an outsourcing agreement on a company's financial condition

Offshore outsourcing investment in emerging economies involves barriers associated with unstable institutions (economic, legal, politics). According to Lessard [73] , "Although expropriation and war are the most visible and dramatic forms that such political risk can take, uncertainty about local governments' economic and

regulatory policies may actually lead to larger reductions in the expected values of overseas projects". So offshore investments, to some extent, represent new locations for the client company and carry the risk of unfamiliarity with local institutional and operating conditions. Lessard [73] described six types of risks moving from the "outer" circle toward the center, these risks are as follows: "(1) world "market price" risks; (2) country macroeconomic and political risks; (3) country-level "price risks"; (4) institutional/regulatory risks; (5) industry level risks, and (6) project/commercial risks".

C. Lack of a Contingency Plan for Major Disruptions at the Service Provider

A well-executed contingency plan, implemented with offshore outsourcing enables client/ service provider to 'flip the switch' at will with no disruption in service [74]. Many medium and small-sized service providers can not afford back-up locations. For example, some client companies and provider have a backup location in case of disruption by India/Pakistan political problems.

V.CONCLUSION AND IMPLICATIONS

Global software development is the key area in software development whose objective is to provide the high quality solutions to the user in reasonable budget and time deadline but as like another engineering discipline; GSD is passing through an era which is full of complexities in terms of risks management. Risk factors can be controlled right after the start phase of the GSD project but it must need a lot of managerial expertise. Although software project management tools and technologies exit but experience and knowledge counts mush more. So it is very much important to understand the impact of different potential risk by a project manager so that the desired results are achieved. Risk management in GSD is not yet fully controlled and thus there needs much more research work. Hopefully this paper will provide a helpful understanding and mitigation guidelines to GSD's developer.

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