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**Software Outsourcing Maintenance:
A Systematic Literature Review Of Investigated Areas**

Bachelor of Science Thesis in the Programme of Software Engineering and Management

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Abstract

In the context of outsourcing, software maintenance becomes an extremely important aspect due to change requirements. Researchers have already studied various topics about software outsourcing maintenance. We have performed a systematic literature review (SLR) process to present areas researchers take interest in about software outsourcing maintenance over the last decade. The areas we define are "Decison Making", "Estimation", "Communication" and "Execution", which are based on our own understanding. Subsequently, we identify challenges, resolutions for challenges and limitations for resolutions in corresponding area to make a comprehensive view in the field of software outsourcing maintenance.

Key Words:software outsourcing maintenance, systematic literature review, hot areas, challenges, resolutions

I. Introduction

The management guru Peter Drucker advises that people should do what you do best, and outsource the rest (Weber, 2004) indicating that outsourcing provides the opportunity for a company to focus its efforts on the activities it considers most important and highlight its competitive advantage, while getting other companies to carry out activities it considers less important (Stark, 2006). With the global economic integration and the enhancing technology, outsourcing has been expanding gradually, especially in software industry. A study by Computer Economics indicates an increasing proportion of software spending on outsourcing, rising from 3.8 percent in 2008 to 7.1 percent in 2010 (Linton, 2011). Nowadays, software companies, both large and small, are embracing the practice of outsourcing within virtually all phases and disciplines. By 2012, the global software outsourcing services market is expected to top 1 trillion US dollars (Effie, 2010). The global client market for software outsourcing is mainly in North America, Western Europe and Japan, and the global vendor market for software outsourcing is mainly in India, Ireland and other countries (Oleg, 2005). Software outsourcing service is the product of the combination between refining social division and software technology development. Although it is a late start comparing with the hardware outsourcing, it has been developing very quickly. It is because the speed of creating changes and new technologies is overtly fast in the software industry (Wilson, 2008). Since human resources and labor costs are much higher than other industries, in this sense software industry needs to allocate corresponding resources more rationally using the form of outsourcing services, divide the labor maximumly and benefit from resources sharing. Simply speaking, software outsourcing can be understood in this way: internal part of the software is completed by another external organization through contract (Your Information Technology Partner).

The software outsourcing lifecycle has two important phases: software development phase and software maintenance phase (Chen et al, 2009). Software outsourcing development phase is equivalent to the modern manufacturing industry which is the output from scratch. Software maintenance phase is different from development phase in many aspects. Software outsourcing maintenance phase puts more emphasis on service which is based on existing functional system and occurs to improve the software product. More than 70% of Fortune 500 companies use outsourcing at various levels of their software activities, especially in maintenance area (Ahmed, 2004). The field we want to research is software outsourcing maintenance. A survey studied by Lientz and Swanson interprets that maintenance activities can be categorized into four types: adaptive type, which means dealing with changes and adapting in the software environment; corrective type, which means dealing with errors found and fixing them; perfective type, which means accommodating with new or changed user requirements that concern functional enhancements to the software; preventive type, which concerns activities whose aim is on increasing software maintainability and preventing problems in the future (Lientz et al, 1980).

In the field of software outsourcing maintenance, the main task is to understand what is going wrong in the existing system and improve the functionalities or correct the anomalies (Robillard et al, 2005). All software maintenance process shares the same conceptual activities which are: identify anomalies, find the causes, implement modification, test modified modules and integrate improved modules into existing software products (Pierre et al, 2007). The testing activities are rather based on regression testing to assure the integrity of the system than on requirements conformance testing. The relative effort on testing should be invested more in the field of software outsourcing maintenance. Software maintenance effort could represent up to 90% of the total cost of typical software products. It is the predominant activity in software engineering studies (Robillard, 2005).

Moreover, maintenance can consume as much as 70% of the lifecycle costs of a software system (Raj et al, 2004).

There exists research papers that study in the field of software outsourcing maintenance due to the universality and significance of maintenance. We want to make a study that attempts to present the areas researchers have studied about over the last decade through systematic literature review method and identify challenges, resolutions for challenges and limitations for resolutions in corresponding area to make a comprehensive view in the field of software outsourcing maintenance. To achieve this we intend to address the following research questions:

RQ1 What are the challenges researchers addressed?
RQ2 What are the resolutions researchers provided?
RQ3 What are the limitations for resolutions?

The paper is organized as follows. Section II describes the related work. Section III describes the research methodology. In Section IV, results of the systematic literature review are presented. In Section V, we discuss the result in Section IV from researchers and practitioners' view, subsequently, discussions between related work and our research questions are interpreted. Section VI describes the limitations. Section VII provides the conclusion and future work.

II Related Research

Software maintenance is well recognized as the most expensive and perhaps, the longest phase in a software development life cycle (Ahmed, 2004). Some papers have already summarized issues researchers have studied in the field of "software outsourcing", so that others can find out the current situation and a variety of topics researchers have already studied about.

Vilvovsky (2008) has tried to bring together the available literatures on software outsourcing in public organizations in order to identify various problems and concerns of public software outsourcing. For example, vendor selection, short term budgets, loss of control over the technology and the current project status, controversy between public service values and the cost-benefit, etc. Based on their findings, they warn of potential problems and risks.

Martens et al (2009) present a systematic literature review on the key risk factors and their specific impact in IT outsourcing, and also propose a reference model for risk management in IT Outsourcing.

Ahmad et al (2009) do a systematic literature review to summarize various factors that are considered critical by clients in the selection of software outsourcing vendor. For example, cost-saving, skilled human resource, appropriate infrastructure, quality of products and services, efficient outsourcing relationships management,etc. The author(s) also suggest that focusing on these factors can help offshore outsourcing vendors to improve their readiness for software outsourcing activities and have a positive impact on software outsourcing clients in the selection process of offshore software development outsourcing vendors.

In another systematic literature review paper Ahmad et al (2009) identify various barriers that have a negative impact on the selection process of software development outsourcing vendors. In order to compete in the offshore outsourcing business, vendors have to address the following barriers: language and cultural barriers; country instability; lack of project management; lack of protection for intellectual property rights;lack of technical capability.

Another paper written by Khan (2011) uses systematic literature review to identify factors which are important in terms of the competitiveness of vendor organizations in attracting outsourcing projects.

The work in our paper complements the work previously done. Since software outsourcing maintenance is an essential part in the frame of software outsourcing, some problems and concerns of public software outsourcing may occur in software outsourcing maintenance, for example: improper monitoring and evaluation of outsourcing contracts will have impact on software outsourcing maintenance. Various factors and barriers that are considered critical by clients to choose offshore software outsourcing vendor are also issues for researchers to study in the context of software outsourcing maintenance. Although there are literatures which illustrate various aspects about one specific area in the context of software outsourcing maintenance, no systematic literature review has been performed on areas researchers have studied about in the field of software outsourcing maintenance. Research on this topic is expected to provide useful information in the context of software outsourcing maintenance.

In this paper we present a study in which a systematic literature review is conducted in order to identify challenges, resolutions for challenges and limitations for resolutions in the field of software outsourcing maintenance.

A good understanding of the challenges involved in software outsourcing maintenance is expected to help us define areas researchers have studied about in the field of software outsourcing maintenance over the last decade. Identify resolutions and limitations will help practitioners choose correct methods. As a result, this study could also point out which areas researchers put more effort on and which areas are lack of research.

We have already collected 27 articles which are associated with software outsourcing maintenance. We have used a systematic literature review process to identify the areas researchers have studied about in software outsourcing maintenance over the last decade. Last but not the least we will put forward our own conclusion to provide recommendations to people who work on software outsourcing maintenance. They can choose appropriate methods so as to work more effectively. As we mentioned there is no article using systematic literature review process which concerns with the areas researchers have already investigated about in the field of software outsourcing maintenance over the last decade. Thus we choose to study this topic and in this way, we contribute to the outsourcing field.

III Research Methodology

We have used a Systematic Literature Review(SLR) process (Kitchenham, 2004) as the approach because Systematic Literature Review could summarize the existing evidence concerning a treatment or technology, in order to draw more general conclusions about some phenomenon than is possible from individual studies (Kitchenham, 2004). Systematic Literature Review is a defined and methodical way of identifying, assessing, and analyzing published primary studies in order to investigate a specific research question. Systematic reviews differ from ordinary literature surveys in being formally planned and methodically executed. They are intended to be independently replicable, and so have a different type of scientific value than ordinary literature surveys. In finding, evaluating, and summarizing all available evidence on a specific research question, a systematic review may provide a greater level of validity in its findings than might be possible in any one of the studies surveyed in the systematic review (Staples et al, 2007).

A. Search Strategies

The search is processed automatically by search engines of specific conference proceedings and journal papers since 2001. Each paper from journal and conference proceeding that related to the research questions is reviewed by two researchers (Han Yang & Fei Qi). In our strategy, we include the primary study that could either be the conceptual study or use different research methods (case study, experiment, survey, etc). We only search for papers that are written in English and available online. The following electronic databases were used:

- IEEE Xplore:
  http://ieeexplore.ieee.org/Xplore/dynhome.jsp
- Elsevier Science Direct:
  http://www.elsevier.com/wps/find/homepage.cws_home
- SpringerLink:
  http://www.springerlink.com/
- ACM Digital library:
  http://portal.acm.org/dl.cfm
- Wiley InterSciene:
  http://eu.wiley.com/WileyCDA/Section/index.html

B. Search Terms

The search terms are built in three steps. First, the key words of each research questions were classified.Second, synonyms for the keywords were defined. Third, the search terms were built by joining the synonyms with operator OR & AND.
- First step: We identify "software", "outsourcing", "maintenance" as keywords
- Second step: Synonyms.   We expand the scope of words we want to search: "software", "IT", "maintenance", "maintained", "service", "vendor", "client", "outsourced", "outsourcing".
- Third step: Boolean Operators. We try different search terms using Boolean operators, such as (software OR IT) AND (maintenance OR maintained OR service) AND (outsourcing OR outsourced OR client OR vendor)

C. Study Selection Criteria

By using search strategies presented above, we found a massive amount of the articles listed in databases. Inclusion criteria are used to determine which piece of literature (conference proceedings and journal papers) found by the search term will be used for the data extraction.

Exclusion criteria are used to determine which piece of literature found by the search term will be excluded (Khan et al., 2009). Primary studies were selected according to the following inclusion and exclusion criteria:

Included Criteria :
- Studies that describe theoretical concepts in the context of software outsourcing maintenance
- Studies that describe software maintenance in the context of outsourcing, or part of their maintenance issues in outsourcing context
- Studies that describe outsourcing software, but still concern about software maintenance as part of their focus or their main focus
- Studies that directly answer one of the research questions

Excluded Criteria:
- Studies that describe maintenance outsourcing without the scope of software engineering, such as manufacturing
- Studies that are part of a book
- Studies that describe software maintenance, but not in outsourcing environment at all

- Studies that describe outsourcing, but do not concern about software maintenance at all
- Studies that mention software maintenance or outsourcing, but not focus on them
- Older version of studies
- Studies showing in progress research or incomplete results

D. Study Selection Process

The selection process was developed in four steps:
- Two researchers performed the searches in order to identify potentially relevant studies. Then, the selection was based on the titles, excluding those papers which are clearly not relevant.
- Two draft lists (one from each investigator), which are resulted from Step1 were merged at this step. Disagreements between the investigators were discussed mutually and consulted with the Supervisor.
- Studies in the resulting list of Step 2 were evaluated by reading abstract. Then, by using the study selection criteria, a final list of relevant studies was created.
- Studies included in the list of relevant studies were displayed using tabular form (Table1).

Table 1 (Data sources)

Resource	Total Results found	First selection	Final selection
IEEE Xplore	265	91	16
ACM	439	107	4
SpringerLink	178	92	3
Elsevier	376	158	2
Wiley	611	45	2

E. Data extraction

We review each article in order to understand the subject authors want to clarify and form a general structure of each article. By reviewing the article, we collected the following information, The research questions in the parenthesis mean the purpose for the data we collected :

- The full references of each primary study.
- The methods researchers use in their research.
- The context of each study. (RQ 1, RQ 2, RQ3)
- The challenges researchers emphasize. (RQ 1)
- The resolutions researchers provide. (RQ 2)
- The limitations of the resolutions for corresponding challenges (RQ 3)
- The role (client or vendor) researchers target. (RQ 3)

F. Data Analysis

Through the "Data extraction" process above, we have collected specific information we need from these 27 literatures and analysed the information. Firstly, we focus on the challenges or problems researchers want to stress, do the researchers have the same purpose or totally different purpose, what are the ties and differences between these articles. Based on this, we divide the challenges we collected into several aspects by own terms, which are Decision Making, Estimation, Communication and Execution. Secondly we analyse other data (background, methods use, resolution, limitation, target) based on the particular aspect above, which can help us figure out the research questions.

For how to extract articles into the four areas, we use three steps. Firstly, identify challenges. The terms in Challenge column are discussed and summarized, based on the challenges researchers want to address. Secondly, categorize challenges. If the challenge is about decision making with strategies, it is categorized into Decision Making area. For example, the challenge of Kobayashi (2005) is "Make appropriate business strategy", it helps client to make rational decisions, so it is categorized into Decision Making area. So are the Estimation, Communication and Execution Area. Thirdly, extract and summarize resolution, target, limitation from corresponding article in order to supplement corresponding challenge.

IV Result

Table 2 shows the detailed information about 27 literatures we have found according to the data extraction and data analysis part (in SectionIII).

In our analysis, we define four areas as a standard principle based on our understanding of the 27 research papers, which are: Decision Making, Estimation, Communication and Execution. The Decision making area focus on the client side to make rational decisions before outsourcing, and also focus on making fair contract with cooperators from the perspective of client; Estimation area puts more emphasis on the vendor side, helps them make appropriate estimation for the maintenance effort, it helps maintainers from the vendor side make suitable contract. Client could also use estimation strategies based on different situations, however, the main target of authors is the vendor; The Communication area makes balance on vendor and client, the focus point is contract making and good relationship establishment. As described above, contract making is the key point across Decision Making, Estimation and Communication areas. The Execution area includes all activities after contract making, such as development, evolution, quality assurance and service. This area is mainly executed by maintenance team, however, the client still needs to participate in some situations, such as resource provided, process monitor, requirement changes or quality assurance.

Table 2

Area	Challenge	Resolution	Target	Limitation	Source
Decision Making	Make rational decision	Suggestions of considering that Maintenance activities are too far from the core of the organization when companies make outsourcing decisions	Client	N/A	Aubert et al, 2002
	Make appropriate business strategy	Pitfalls and suggestions for companies to outsource to India (different time zone; if decided to outsource,strictly define the source code and document control system is required;Note Indian English may lead misunderstanding)	Client	Indian outsourcing	Kobayashi, 2005
	Frame an IT outsourcing decision problem	A guideline on how to make appropriate decisions from a knowledge management perspective (Step1: Analysis of Current, Transition and outsourcing Situation; Step2: gap analysis for current,transition and outsourcing situation;Step3: If possible, how to bridge the gap)	Client	Large international financial institute	Mehmet et al, 2008
	Make appropriate decisions to maintain and upgrade ERP systems.	The motivation to maintain and upgrade ERP systems, and a corresponding decision model to manage maintenance and upgrades (Decision alternatives, tradeoffs involved in decision alternatives)	Client	ERP(enterprise resource planning) systems	Ng, 2001
		The situations of ERP systems, and introduce proposed ERP maintenance taxonomy to help client side make appropriate decision which include who is the maintenance source, why is it important to service the request and whether there is any impact of implementing the request on the installed modules .	Client	ERP(enterprise resource planning) systems	Ng et al, 2002
	Reach to reliable&cost-effective maintenance	Adequate measures which can be taken in advance (selection criteria for vendor, number of vendors needed, roles and responsibilities, risk analysis, service level agreements, and questions considered to make maintenance contract)	Client	N/A	Ahmed, 2006
Estimation	Estimate maintenance effort	Holistic approach towards a study of the factors affecting the effort involved in maintenance of existing software systems. Methods for building a systems dynamics model to predict the effort involved to maintain a software system, based on qualitative and quantitative inputs.	Vendor	N/A	Bhatt et al, 2004
		Factors (system baseline, customer attitude, organizational climate, maintenance team) & their relationships	Vendor	N/A	Bhatt et al, 2006
		Factors (system baseline, customer attitude, organizational climate, maintenance team) & their influence on maintenance effort(the four factors above and maintenance effort) & a model to predict and control the impact of various factors on maintenance effort	Vendor	Business information systems	Bhatt et al, 2006
		Factors (system baseline, customer attitude, organizational climate, maintenance team) & their relationships & influence on software maintenance activities and effort		Medium to large business system	Bhatt et al, 2006
		A method (code metrics) to estimate maintenance effort (Identify type of maintenance, correlating data through logistic regression, categorizing the data,applying logistic regression,prediction equations)	Vendor	Banking applications developed in Cobol/CICS	Polo et al, 2001
		A framework of metrics to evaluate the complexity of a legacy software	Vendor	Legacy software	Ramos et al, 2004
		Applicability of IEEE maintenance process to estimate effort on maintenance activities: identify activities and estimate effort based on hours	Vendor	Corrective maintenance	Rao et al, 2002
		Find five most significant parameters that effect the efforts of maintenance (multi time zone support, average number of lines per program, percentage of online programs in the total system, the nature of service level agreements, the complexity of the file system being used)	Vendor	Corrective maintenance	Rao et al, 2003
		Effort estimation technique (identifying elementary software entities, tracing source entity relationships, tracing error reports and change requests)	Vendor	Large-scale web application	Sneed et al, 2007
	Estimate staff requirement	A process (computing the number of personnel, lower bound for the service rate, economies of scale) to estimate team size, shows the minimum staff requirement to meet SLA (service level agreements) .	Vendor	N/A	Jai et al, 2005
Communication	Establish a good relationship and realize win-win for both client and vendor	Processes,techniques & tools run a remote software maintenance operation,the legalities of contracts & economics of outsourced services: negotiating a service level agreement, establishing a maintenance infrastructure, setting up a maintenance process, automating the maintenance process, servicing multiple customers at one time	Vendor &Client	Legacy software	Sneed, 2008
		Issues (the evolution of workflow integration within clients and dynamic	Vendor	E-business	Von et al,

		reconfiguration of distributed applications, the benefits of multiple, concurrent service versions with respect to serialized service versions, the termination period of a service should be present in a service contract, notion of cross-organizational dependencies, how to compute the availability time of a service) related with Service contract	&Client		2005
Execution	Quickly identify&prioritize actions targeting the product	A method (Orthogonal Defect Classification) for identifying process and product weaknesses: 1. Collect ODC classified historical defect data and subset based on source and/or age. 2. Use evaluation techniques on one or more attributes to define the characteristics relative to internal defect removal activities, prevention activities, and customer usage. 3. Identify weaknesses and strengths and the most likely activities to target them. 4. Execute actions and measure the results	Vendor	Ported,outsourced& legacy software	Bassin et al, 2001
	Control resource allocation（time）	A model (includes Work store,Work Factory, SLA Constraint, Managerial constraint) to control resource allocation within SLA (service level agreements) constraints.	Vendor	N/A	Kundu et al, 2011
	Manage resources(code, document) of maintenance project	A collaborative platform (CollabDev) for managing and sharing the domain specific knowledge	Vendor	The resolution (CollabDev) is in prototype stage	Sarkar et al, 2008
	Find a guideline to manage outsourcing maintenance project	Strategy that based on MANTEMA (A model that Integrate outsourcing activities): initial study, process implementation, middle activities and tasks of the MANTEMA maintenance process, Common final activities and tasks	Vendor &Client	N/A	Polo et al, 2002
		Process model (management, technical, support) to manage a software testing factory	Vendor &Client	N/A	Sanz, et al, 2009
	Migrate risks	Reference model (defines the required activities, artifacts, roles and their relationships) for maintenance process	Vendor &Client	Corrective maintenance	Robillard et al,2007
		Measures(Build Management, Communication, Collaboration Process, Project Management, Requirement Management, Testing Strategy) to mitigate problems in outsourced maintenance project	Vendor	Power plant engineering sector	Seybold et al, 2008
	Improve efficiency	Execution model for tracking execution of programs and flow of maintenance activities: collect the list of all the programs,create the initial node of the network, repeat until the final node of the network is reached, identify dependent and feeder nodes.	Vendor	Corrective maintenance	Rao et al , 2005
	Improve stakeholder satisfaction	A shift-pattern model (From 'serving the application' to 'serving the stakeholder'; From 'engaging faceless stakeholders' to 'engaging the 'hidden' stakeholder community'; From 'skewed stakeholder democracy' to 'balanced stakeholder democracy')	Vendor &Client	Enterprise level	Bhat et al, 2007

As Table 2 shows, we define fours areas researchers take interest in about software outsourcing maintenance: Decision making, Estimation, Communication and Execution. In each area, there are some challenges researchers try to solve. There are also corresponding resolutions provided by different researchers. These resolutions have their specific target roles (client or vendor or both of them) and limitations.

In the Decision Making area, there is a discussion of whether or not to outsource software maintenance phase to the third party, mainly focus on outsourcing benefits, challenges and risks. Reliable maintenance is only possible if adequate measures are taken in advance during maintenance planning phase and are documented in the maintenance contract (Ahmed, 2006). Researchers also devote in the situation where a company decides to outsource their maintenance activities, how to choose the outsourcing organizations, how to assign responsible task, how to allocate resources and how to make a suitable contract with the expected outsourcing vendor in order to get the benefits and prevent failure. Different researchers provide different

resolutions, when a company tries to choose methods before or during the contract process, it is recommended to think the characteristics of product that being maintained, what are the purposes and whether or not there are any limitations for the method choosing.

It could be seen that researchers study a lot in the Estimation area, 10 of 27 articles are about estimating effort. It is also an area that participates in the outsourcing software maintenance before execution, and it is an important area to make contract from the point of vendor. Before execution, vendor needs to estimate the amount of the workload, in case to decide whether or not they could accept the maintenance work, what level of service they could apply and how much they need to ask for in order to get the benefits. A few researchers also point out that even client side could use their method for some specific situations, such as tracing the maintenance activities executed by vendor and having a better understanding of the product that they want to outsource. As a whole, there exists three problems for estimation area. Firstly, what are the factors that impact

maintenance effort? Bhatt et al (2004; 2006) make a deep study about this problem and summarize in four categories: System Baseline, Customer Attitude, Organization Climate and Maintenance team. Rao et at (2003) also study on that to find the most important factors that impact maintenance effort. Secondly, how to estimate maintenance effort? This problem emphasizes on the approach to estimate in order to have an overview of the software maintained and evaluate cost. Basically, the methods focus on analyzing the resources provided by client in initial phase, some methods also include the future cases, such as change requests or error reports. Thirdly, Calculate the impacts of the factors. By searching from this perspective, people could make a better control and predict on the maintenance effort. When searching for this problem, researchers mostly use quantitative methods to measure and the results have a coherent relationship with practice, as they use real companies as their study object. In this case, such study has its own limitation. When people want to reference to the metrics or models, they need to care about the limitations.

Communication is an area mainly focus on contract and the corresponding issues related with contract, such as SLA (service level agreements). Contract needs to be carefully signed in case of conflicting in the following process. Although there are just two articles for Communication area, we could not say researchers put less effort on that, as Decision Making and Estimation area also has its own focus on Communication area. The difference is that Decision Making area stands by the clients' view and Estimation area stands by the vendors' view. If people want to establish good relationship and realize win-win, they still need to reference to Decision Making area or Estimation area.

Execution area concerns with software maintenance development, software evolution (concerns with changes), quality assurance, delivery and related issues with software execution, such as communication, resource management. As we could see, there are a lot of issues that related with Execution area, but there are not as much literatures as possible that concerns with this area. However, the guidelines or methods provided by researchers are valuable. Basically, there are two issues researchers concern with: maintenance activities management and maintenance resources management. For the maintenance activities management, researchers provide models, usually include required activities, artifacts, roles and their relationships. These models could be based on the authors' experiences or based on existing models. For the maintenance resources

management, researchers emphasize on cost, time, and system artifacts. As a whole, in the area of execution, the main purpose of researchers is to help maintenance team conduct maintenance activities more efficient and correct, migrate risks, reduce costs, and finally meet the requirement of client or SLA (service level agreements).

V Discussion

From the result above, we could see researchers put more effort on initial phase of outsourcing maintenance, especially decision making from the perspective of client, and effort estimation from the perspective of vendor. It is good to see everything is pre-defined in advance, it is a good way to prevent failure. There is a consensus that application maintenance takes up the majority of the effort in the life cycle of the application software and the percentage of efforts spent on maintenance has increased over the years (Kundu et al, 2011). Thus, people need to put more effort and more cost on software maintenance. In this case, people need to be more careful about outsourcing the maintenance activities, as benefits following with risks and challenges. Correspondingly, the IT vendors allocate the resources based on previous experience and common sense (Kundu et al, 2011). By estimating resources and efforts, vendor side also needs to be careful about accepting maintenance business. Based on the analysis above, it is reasonable to see researchers put more effort on how to make rational decisions and how to estimate maintenance effort.

Practitioners need to be careful about the limitations for the methods, basically, there are four kinds of limitations: Firstly, the methods themselves need to be improved or examined, such as improve from theoretical method to practical method. Secondly,environment limitations, the methods are extracted from a specific environment which may not be used for other environments. Thirdly, system limitations, the methods focus on specific system, for example, web system, which may not be used for other systems. Fourthly, maintenance type limitation, the methods are only for specific maintenance type, for example, corrective maintenance, which may not be used for other maintenance types.

To have a look at how does our research supplement to the related research in outsourcing, we collected articles searching in the context of outsourcing which also use systematic literature review, it is displayed in section 2. As a conclusion, Ahman et al (2009) focus on choosing software outsourcing vendors: success factors and barriers; Khan

(2011) also focuses on vendors, but concerns with competitiveness of vendor organizations in attracting outsourcing projects. Vilvovsky (2008) identifying various problems and concerns of public software outsourcing; Martens (2009) concerns with key risk factors and their specific impact on IT outsourcing.

Previous research were included outsourcing in general which also includes software development outsourcing, web-based outsourcing, our study focuses on the maintenance process in outsourcing. In outsourcing maintenance, the required understanding of the existing systems is different from the requirement analysis of the future systems which indicates much more estimation effort. The testing activities are rather based on regression testing to assure the integrity of the system than on requirement conformance testing. The relative effort on testing is also larger on maintenance process (Robillard et al, 2007). Although there are a lot of differences, we see that some issues related with general outsourcing also related with maintenance outsourcing.

From the result, we find that in the software outsourcing maintenance area, people also concern about how to choose outsourcing vendors, which mostly occurs in the area of Decision Making. The difference is the choosing criteria is much more strict than general outsourcing, as maintenance process is different, it requires new activities. For example, maintainers need to analyze in depth the system to be modified. This means understanding the details of the existing system (Robillard et al, 2007). Correspondingly, outsourcing vendors also face bigger challenge in attracting outsourcing projects. They need to correctly analyze the maintenance effort, and decide whether or not they could meet the requirement.

In the Decision Making area, lots of researchers point out the problems, risks that following with benefits to help people make rational decisions. There also exist risks in other three areas: Estimation, Communication and Execution. Compared to previous research, risk factors for maintenance are not the same. The mitigation of risks is different. In general outsourcing, problems include lack of quality, slipped deadlines, and communication overhead. These risks also occur in outsourcing maintenance, however, software maintenance typically requires intensive customer contact, short iteration cycles, and fast response times which is counter to the communication delays, requirements misinterpretations and indirect responsibilities often found in outsourcing cooperations (Seybold et al, 2008). we could see

that the problems and risks in software outsourcing maintenance are more serious than related work which just concerns with general risks and problems.

In conclusion, there are two important differences in our study compared with related research: Firstly, we focus on software outsourcing maintenance which is a unique point of penetration. Secondly, although some areas in maintenance have overlaps with related research (choosing vendor and identify risks), we divided areas in a different way, which are Decision Making, Estimation, Communication and Execution. We think this way is useful for people to have an overview from the point of software outsourcing maintenance.

VI Limitations

Like other studies, this study also has certain limitations that should be reminded while considering the reported conclusions.With the increasing number of studies in this area, this review may have missed some papers in the context of software outsourcing maintenance. Due to time restrictions, the search did not consider some databases Kitchenham suggested: InspecDirect, Scirus eScopus. Our search was restricted to papers published in English. It is possible that papers can show interesting insights and new thoughts in other languages. Although this may represent a limitation and a threat to validity, the main conference proceedings and journal papers about software outsourcing maintenance have been searched, reducing the problem to some extent.

VII Conclusion and Future Work

As software technology is developing, software outsourcing maintenance has become an increasingly popular topic.This paper presents a systematic literature review in the context of software outsourcing maintenance with the following conclusions:

We defined four areas researchers have studied about in the field of software outsourcing maintenance over the last decade which are: Decision Making, Estimation, Communication and Execution. We also identify the challenges, resolutions for challenges and limitations for resolutions in corresponding area to make a comprehensive view and guide people who work in this area. Subsequently, we interpret the relationship between our study and related research which also use systematic literature review method in software outsourcing, highlight similarities and differences. In addition, we identify what areas researchers put more

effort on and what areas researchers put less effort on. To explain why leads to this state, we interpret from the view of property in software outsourcing maintenance.

In future work, we would like to research the areas we defined in depth, especially Estimation area and Execution area. Estimation area is an interesting area which differs software outsourcing maintenance from software outsourcing development (Robillard et al, 2007), it is an area that deserves researching deeply. Execution area is the area that researchers put less effort on in the context of software outsourcing maintenance which also deserves researching. Based on what we have done in this systematic literature review paper, we would like to use empirical methods to conduct future research, such as interview or case study. We would like to focus on the existing resolutions that identified in this paper to provide a supported body of knowledge about the challenges we clarify and to provide empirical recommendations to people. We encourage independent studies on this topic. This will increase confidence in our conclusions and also demonstrate to people on areas researchers have studied about in the field of software outsourcing maintenance over the last decade and corresponding issues we discuss.

Reference

Ahmed R.E., 2004, "Maintenance Issues In Outsourced Software Components",Electrical and Computer Engineering,ISSN.0840-7789,Canadian Conference on, vol. 1, pp. 129~132.

Ahmad R., Niazi M., Khan S.U., 2009, "Critical Success Factors for Offshore Software Development Outsourcing Vendors:A Systematic Literature Review" Digital Object Identifier:10.1109/ICGSE.2009.28, Page(s):207-216, Fourth IEEE International Conference

Ahmad R., Niazi M., Khan S.U., 2009, "Critical Barriers for Offshore Software Development Outsourcing Vendors: A Systematic Literature Review" , Digital Object Identifier:10.1109/APSEC.2009.16 Page(s):79-86 , Software Engineering Conference.APSEC'09.Asia-Pacific

Ahmed R.E., 2006, "Software maintenance outsourcing:Issues and strategies", Vol. 32, Issue. 6, pp. 449~453, Computers&Electrical Engineering.

Aubert B.A., Beaurivage,G., Croteau,A.M., Rivard,S., 2002, "Firm strategic profile and IT outsourcing", vol. 10, No. 2, pp. 129~143, Information Technology and Management, 2002 Kluwer Academic Publishers.

Babar M.A., He Z., 2009, "Systematic literature reviews in software engineering: Preliminary results from interviews with researchers", Digital Object Identifier: 10.1109/ESEM.2009.5314235, Page(s):346-355

Bassin K., Santhanam,P., 2001, "managing the maintenance of ported, outsourced and legacy software via orthogonal defect classification", pp. 726~734, IEEE conferences.

Bhat J.M., Gupta M., 2007, "Enhancing Requirement Stakeholder Satisfaction during Far-shore Maintenance of Custome Developed Software using Shift-Pattern Model", pp 322~327, ISSN. 1090-705X, IEEE Conferences.

Bhatt P., Shroff G., Anantaram C., Misra A.K., 2006, "An Influence Model for Factors in Outsourced Software Maintenance", Vol. 18, Issue. 6, pp. 385~423, Journal of Software Maintenance and Evolution:Research and Practice.

Bhatt P., Shroff G., Williams K., Misra A.K., 2006, "An Empirical Study of Factors and their Relationships in Outsourced Software Maintenance", ISSN. 1530-1362, pp.301~308, IEEE Conferences.

Bhatt P., Shroff G., Misra A.K., 2004, "Dynamics of software maintenance", Vol. 29, Issue. 5, ISSN. 0163-5948, pp. 1~5, ACM SIGSOFT Software Engineering Notes.

Bhatt P., Williams K., Shroff G., Misra A.K., 2006, "Influencing factors in outsourced software maintenance", vol. 31, issue. 3, pp. 1~6, ISSN. 0163-5948, ACM SIGSOFT Software Engineering Notes.

Chen J.C., Sun-Jen H , 2009, "An empirical analysis of the impact of software development problem factors on software maintainability" , Volume:82, Issue:6 Publisher:Elsevier Inc. Pages:981-992 ISSN: 01641212, Journal of Systems   and Software

Effie S., 2010, "China Software Outsourcing Part I-New IT Giant", Beijing RayooTech Co.,Ltd Building A UFIDA Software Park   No 68,Beiqing Road,Haidian District Beijing,P.R. China 100094 http://www.unisoftchina.com/china-software-outsourcing.pdf

Harry M.S, Peter B., 2003, "Critical Success Factors in Software Maintenance A Case Study", Proceeding of the International Conference on Software Maintenance(ICSM) IEEE Software Data Service, Vienna, Austria.

Jai A., Sarkar S., 2005, "Staffing Software Maintenance and Support Projects", ISSN. 1530-1605, pp. 314b, IEEE Conferences.

Khan S.U., Niazi M., Ahmad R., 2011, "Factors influencing clients in the selection of offshore software outsourcing vendors:An exploratory study using a systematic literature review" Volume 84, Issue 4, Pages 686-699, The ninth International Conference on Quality Software, Journal of Systems and Software

Kitchenham B., 2004, "Procedures for Performing Systematic Reviews", Software Engineering Group, Department of Computer Science, Keele University, ISSN.1353-7776.

Kitchenham B., Charters S., 2007, "Guidelines for performing Systematic Literature Reviews in Software Engineering" , Vol 2.3 EBSE Technical Report,   Software Engineering Group, School of Computer Science and Mathematics, Keele University, UK

Kobayashi M., 2005, "A Passage to India-Pitfalls that the outsourcing vendor forgot to mention", Vol. 3, No. 1, ISSN. 1542-7730, pp. 54~60, ACM New York.

Kundu J., Mukherjee A., 2011, "A Novel Approach to Manage IT Application Maintenance Projects" , ISSN.15300-1362,pp.331~334 IEEE Conferences.

Lientz B., Swanson E.B., 1980, "Software Maintenance Management: A Study of the Maintenance of Computer Application Software in 487 Data Processing Organizations", Addison-Wesley,Reading,Mass.

Linton L., 2011, "Factors for IT Outsourcing" , eHow Contributor , http://www.ehow.com/info_8176494_factors-outsourcing.html

Martens B., Teuteberg F., 2009, "Why risk managemetn matters in IT outsourcing-A systematic literature review and elements of a research agenda" , ECIS 2009 Proceedings, Paper 79

Mehmet N.A., Mark E.B., 2008, "Analyzing IT maintenance outsourcing decision from a knowledge management perspective", vol. 10, No. 3, pp. 293~305, Special Issue on Decision Models for Information Systems Management, Guest Editors: Kweku-Muata Osei-Bryson and Ojelanki Ngwenyama.

Ng C.S.P., 2001, "A decision framework for enterprise resource planning maintenance and upgrade:A Client perspective",vol.13, issue. 6, pp. 431~468, Journal of software maintenance and Evolution:Research and Practice.

Ng C.S.P., Gable G.G., Chan T., 2002, "An ERP-client benefit-oriented maintenance taxonomy", vol. 64, issue 2., pp. 87~109, Journal of Systems and Software

Oleg I., 2005, "Outsourcing Of Software Development", Humbold Universität zu Berlin Wirtschaftwissenschaftliche Fakultät, http://www.seoresearcher.com/research/Outsourcing-of-Software-Development.pdf

Pankaj B, Gautam S,Williams K., Arun K.M., 2006, "An Empirical Study of Factors and their Relationships in Outsourced Software Maintenance" , XIII ASIA PACIFIC SOFTWARE CONFERENCE   IEEE

Pierre N.R., Noureddine K., Martin T., Hamid H., 2007, "Outsourcing Software Maintenance:Process,Standard&Critical

Pracices",Electrical and Computer Engineering,Canadian Conference

Polo M., Piattini M., Ruiz F., 2001, "Using code metrics to predict maintenance of legacy programs:a case study", pp. 202~208, IEEE Conferences.

Polo M., Piattini M., Ruiz F., 2002, "Integrating Outsourcing in the Maintenance Process", vol. No. 3, pp. 247~269, Information Technology and Management, 2002 Kluwer Academic Publishers.

Raj S.H., Delaurier,D., 2004, "An approach to measure software maintenance and support as a value added component of   today's business." 20th IEEE Internationa l Conference on Software Maintenance,Chicago,IL,USA, pp 503-504

Ramos C.S., Oliveira K.M., Anquetil N., 2004, "Legacy software evaluation model for outsourced maintainer", ISSN. 1534- 5351, pp. 48~57, IEEE Conferences.

Rao B.S., Sarda N. L., 2002, "Applicability of IEEE Maintenance Process for Corrective Maintenance Outsourcing - An Empirical Study", International conference on Software Maintenance, ISSN. 1063-6773, pp. 74~83 IEEE Conference.

Rao B.S., Sarda N.L., 2003, "Effort drivers in maintenance outsourcing-an experiment using Taguchi's methodology", ISSN.1534-5351, pp. 271~280, IEEE Conferences.

Rao B.S., Sarda N.L., 2005, "Execution model for outsourced corrective maintenance", pp. 944-948, IEEE Conferences.

Riaz M., Mendes E., Ewan T., 2009, "A systematic review of software maintainability prediction and metrics" ,Proceedings of the 2009 3rd International Symposium on Empirical Software Engineering and Measurement, IEEE Computer Society

Robillard P.N., 2005, "Opportunistic problem solving in software engineering", IEEE Software, vol.22, no.6 ,pp 60-67

Robillard P.N.,Kerzazi N.,Tapp M.,Hmima H., 2007, "Outsourcing Software Maintenance:Processes,Standards&Critical Practices",ISSN. 0840-7789, pp. 682~685, IEEE Conferences.

Sanz A., Garcia J., Saldana J., Amescua A., 2009, "A proposal of a process model to create a test factory", pp. 65~70, IEEE Conferences.

Sarkar S., Sindhgatta R., Pooloth K., 2008, "A collaborative platform for application knowledge management in software maintenance projects", No.2, ACM Bangalore Chapter Annual Conference.

Seybold C., Keller R.K., 2008,"Aligning Software Maintenance to the Offshore Reality", pp. 33~42, ISSN. 1534-5351, IEEE Conferences.

Sneed H.M., 2008, "Offering software maintenance as an offshore service",ISSN. 1063-6773, pp. 1~5, IEEE Conferences.

Sneed H., Huang S., 2007, "Sizing Maintenance Tasks for Web Applications", ISSN: 1534-5351, pp. 171~180, Software Maintenance and Reengineering, IEEE Conferences.

Staples M., Niazi M., 2007, "Experiences using systematic review guidelines", Vol 80,Issue 9, Pages 1425-1437, Evaluation and Assessment in Software Engineering-EASE 06

Stark J., 2006, "Product lifecycle management:21st century paradigm for product realisation" ISBN. 1-85233-810-5, Decision Engineering Series, ISSN. 1619-5736 , Springer-Verlag London Limited, 3rd printing

Von S.O., Dugerdil P., 2005, "Cross-organizational service maintenance using temporal availability specification and contracts", pp. 230~239, ISSN. 1063-6773, IEEE Conferences.

Vilvovsky S.,2008,"Differences between public and private IT outsourcing:common themes in the literature" Proceeding dg.o'08 Proceeding of the 2008 international conference on Digital government research, ISBN: 978-1-60558-099-9

Weber A.I., 2004, "The advantages of outsourcing financial and accounting services with the right firm" ,Association Management , http://www.allbusiness.com/human-resources/workforce-management-hiring/2235351.html

Wilson K.D., 2008, "Compliance in an Outsourced World" ,http://www.citadelcompliance.com/Docs/Compliance%20in20an%20Outsourced%20WorldJuly212008.pdf