Towards Offshore Software Maintenance Outsourcing Process Model

Atif Ikram[1,2], Masita Abdul Jalil[1], Amir Bin Ngah[1], Ahmad Salman Khan[3],
aikram4u@gmail.com
[1] School of Informatics and Applied Mathematics, Universiti Malaysia Terengganu, Malaysia
[2] Department of CS&IT, The University of Lahore, Pakistan
[3] Department of Software Engineering, The University of Lahore, Pakistan

Summary
Software maintenance outsourcing (SMO) is performed from developed countries to developing countries to gain different advantages like reducing the cost and securing time to pay attention to research and development of new products. This process of outsourcing between two (or more) different countries is called offshore software maintenance outsourcing. Both client and vendor face different kinds of problems during the execution of offshore software maintenance outsourcing (OSMO). In literature, a considerable contribution exists for software development outsourcing but OSMO is still an under-researched activity. This study aims to propose an OSMO process model. The proposed OSMO process model will address the problems of both client and vendor in the OSMO context. It is expected that the proposed an OSMO process model will help both the client and vendor organizations to make the OSMO services a success story

Key words:
Offshore, Software Maintenance, Outsourcing, Process Model, Machine Learning.

1. Introduction

Software systems play a vital role in our daily life. The moment a software system is deployed in some operational setting, it enters into the maintenance phase. The maintenance is required to keep the software system alive according to customer needs. IT organizations have to depute software maintenance teams to provide software maintenance services. Software maintenance outsourcing includes outsourcing of pre and post-delivery activities, code maintenance, bug fixing, feature enhancement, GUI enhancement, software upgrades [6,13], etc. Literature divides maintenance into four categories named as corrective (bug fixing), adaptive (to cope with environmental change), perfective (changes originated from user request) [7] and preventive maintenance (to make software more maintainable) [8]. Software maintenance is the lengthiest stage by covering around 70% cost of a software lifecycle [9,10] and requires a lot of effort [63,65].

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Software maintenance outsourcing is a complex activity spanning across the whole lifecycle of the system involving multiple stakeholders. Offshore outsourcing is a practice in which companies hire services (or products) from another country. Offshore software maintenance outsourcing (OSMO) domain brings more complexity for stakeholders involved [41]. These stakeholders face many challenges. The challenges begin from the early phase of deciding on outsourcing the software maintenance till the system retirement. The retirement process is the retirement of an existing system by withdrawing it from operation and support [11].

The studies [1,2,3] and additional ones, indicated in Section 5 of this study, discuss challenges and issues related to software maintenance outsourcing but offshore context is missing.

The poor management of SMO may lead to poor quality of maintenance services and in the worst case could lead to business loss, as maintenance covers a major portion (70%) of SDLC [9,10]. So, it is praiseworthy and of significant importance to propose such a process model that can address offshore software maintenance outsourcing related issues. The aim of this study is to propose an OSMO Process Model. The proposed model will address OSMO related issues from decision-making until the execution of software maintenance outsourcing.

The remaining of the current study is as follows. Section 2 is about Problem Statement, Section 3 is about Objectives, Section 4 is about Scope, Section 5 is about Literature review, Section 6 contains Proposed model, Section 7 is about Research methodology while Section 8 is about Conclusion and Expected results of the current study.

2. Problem Statement

In OSMO the software maintenance related services (activities) are outsourced from developed countries towards developing countries. In the outsourcing process, developed countries are known as client and developing countries are known as vendors. Both vendors and clients

face different kinds of issues during the outsourcing process. The current study identifies these issues and recommends an OSMO process model to address these issues. The studies [61,62,66] shows that the trend of SMO is on a positive trend. In literature, researchers have provided different solutions for SMO [1,2,3,61] but OSMO has not captured major attention. The current study, specifically, deals with the OSMO context.

3. Objectives

The main objective of this research is to facilitate stakeholders involved in the OSMO process. The OSMO process model will facilitate in deciding about outsourcing decisions, writing service level agreements, handing-over software and software-related documents, execution of the OSMO process and to mitigate risks involved. This can be done by proposing an OSMO process model. The model will provide a predictable platform for OSMO stakeholders in an erratic situation. It means that the model will provide a platform for the OSMO stakeholder to predict their business activities, in an uncertain situation. This research will propose a validated OSMO process model.

Specifically, the study aims to achieve the following objectives:

(i) To identify the challenges faced by stakeholders (both client and vendor) involved in the OSMO process

(ii) To propose an OSMO process model

(iii) To propose a method(s) for the validation of OSMO process model

4. Scope

The current study deals with issues faced by software maintenance outsourcing stakeholders. It focuses on the offshore context only. The study will identify these issues through a systematic literature review (SLR). The study will propose an OSMO process model to address these issues. The one cluster of OSMO process models will be validated through expert judgment and machine learning techniques. The study will also develop a web-based tool to help OSMO vendor in the selection of an appropriate proposal of any client.

5. Literature Review

In literature, there exist few models and frameworks which are related to offshore software maintenance outsourcing. Table 1 presents the summary of existing (in literature) frameworks and process models. Table 1 shows the limitations of existing literature concerning the OSMO process model. The study [17] proposed a factor-based model. This model helps the software practitioners to predict (assess) about software maintenance efforts on the bases of identified factors. These identified factors include insufficient information regarding the size and complexity of code, organization's climate, client's attitude, etc. The study [17] claims that these identified factors have a direct influence on software maintenance outsourcing. This study [17] is not specific to offshore software maintenance outsourcing. The study [50] presented a model that explains how both internal and external factors influence the software outsourcing decision-making process. The internal factors include cost reduction, focus on principal capabilities, business and process improvements, technical and political reasons, concerns of intellectual property, rapid delivery, etc. The model presented in the study [50] failed to explicitly explain the software outsourcing decisions in the selected case. The study [55] presented a readiness assessment model for the client's organization which can be used before the implementation of software outsourcing. This readiness model is based on six dimensions that are human, strategic, process, organizational
managerial and technological. This model provides good practices to assess the level of readiness of any organization to safeguard the success of its software outsourcing business. The study [57] presented a model to assess the internal readiness of an organization for offshore software outsourcing. This study [57] claims that offshoring readiness has a strong relationship with the strategy of offshoring companies. These strategies can be offshoring, local outsourcing or in-house solutions. The terms used in this study are generic rather than specific to software maintenance. The study focuses on only one country. The outcome of the study [58] is readiness model for software outsourcing. The model is based on six internal and three external dimensions. The study [57] and [58] are similar.

The study [48] has focused on vendor capability and presented a framework that describes the capability development of the offshore vendor. This framework can be used in vendor selection and has not been validated empirically. Besides, this framework is generic and not specific to offshore software maintenance outsourcing.

Table 1: Existing frameworks and process models

ID	Phase related to SMO
[17]	Assessment
[50]	Decision of Outsourcing
[55]	Assessment (readiness of client and vendor)
[57]	Assessment (Client's Readiness)

[58]	Assessment Model (Readiness)
[48]	Vendor selection
[53]	Contract, Client-vendor relationship
[56]	Service Level Agreement (SLA)
[59]	SLA, Vendor selection
[29]	Handover
[51]	Handover, Communication, Execution
[52]	Handover (knowledge sharing)
[60]	Handover (transfer, learning, adaptation)
[1]	Execution
[3]	Execution of outsourcing, Risk factor
[36]	Execution of outsourcing
[43]	Execution (Communication and coordination)
[44]	Execution
[45]	Execution (Task allocation)
[46]	Execution (requirement change management, communication)
[4]	Maintenance Management
[33]	Knowledge management
[49]	Risk
[41]	Risk
[42]	Risk
[54]	Risk
[5]	Relationship between client and vendor, Risk
[47]	Software Process Improvement in GSD
[61]	More focus on SMO rather than OSMO

The study [53] provided directions towards a model for the effective governance of client-vendor relationships in information system out-sourcing under formal contracts. The findings are fully based on literature review and no industrial validation is performed. Moreover, the study [56] proposed an evidence-based framework for a realistic service level agreement (SLA). This framework has used techniques like process mining, goal programming, and simulation. The study did not focus on OSMO. Moreover, the study [59] provides a conceptual framework to deal with software outsourcing risks related to service level agreement (SLA). The framework used expert opinion and Delphi techniques. The reported study also discovered the trust factor between client and vendor under the contract or SLA. The framework proposed by the study [59] requires industrial validation.

The study [29] offered a framework for software handover. The presented framework is a good effort towards the handover of software systems but with some limitations as per the scope of current research. The framework presented in the study [29] does not cover the off-shore context of software maintenance. The study [51] have discussed handover (transfer of knowledge) along with other different issues faced by software maintenance outsourcing stakeholders. The study [51] pointed out that cultural understanding is very important to make a successful transfer of knowledge. The study focused on small level business only. The study [52] proposed 3 schemes of a process model in the OSMO context. The objective of the process model is to govern the individual learning during the knowledge handover (knowledge sharing) process. The study [52] has investigated only successful projects. The study selected only onsite vendor arrangers. All the projects are only in one direction that is time-and-material based.

The study [3] has emphasized that software maintenance outsourcing organizations should rely on a “technological associate” for the execution of software maintenance outsourcing. The study [3] has not covered the offshore context of software maintenance. The study [36] discussed activities performed and challenges faced during the execution of outsourced software maintenance. The study presented an execution model. This model will not help the execution of maintenance requests but also reduce the time by making quick decisions. The study [36] focused on corrective maintenance only. The study [43] has a model to mitigate software outsourcing execution challenges like coordination and communication. The study used a fuzzy method approach called FMADM. The study [43] has focused on software development rather than software maintenance. The study [44] focused on requirements change management issues that arise during the execution of software maintenance outsourcing.

The study [44] has classified the identified challenges under different categories like client-vendor and time-based challenges. The challenges are also categorized for a software process improvement model, into 6 knowledge areas. The study [44] is not an empirical study as well as requires proper validation. The study [45] has investigated such factors that harm the task allocation process during the execution of software development outsourcing. The study has categorized the factors into four classes like coordination, team, technology and project administration. The study [45] has focused on offshore software development outsourcing rather than OSMO. The study [49] has investigated such risks that are associated with offshore software maintenance outsourcing. The study focused risks along with different areas, vendors and culture. The study provided best practices to be adopted by OSMO stakeholders involved. The study [49] was limited to only one vendor.

The existing literature identifies the issues faced by both the client-side and the vendor-side of OSMO. It is obvious from the literature gap that there should be such a process model that can handle OSMO related issues faced by OSMO stakeholders involved.

6. Proposed Model

The detailed discussion highlights that an OSMO process model is inevitable. Although some researchers have worked in OSMO related areas but still a lot of work is required to have an OSMO process model. Figure 1 shows the proposed OSMO process model. This model has been proposed on the research gap (information) extracted from Table 1. The proposed OSMO process model consists of six clusters named Decision-Making, Proposal assessment, Service Level Agreement (SLA), Handover, Execution, and Risk. In the future, with the help of a systematic literature review, each cluster will have more details like activities, roles, work products, tools, etc.

Decision-Making:

The initial challenge faced by the customer during the OSMO process is decision making. The stakeholders involved have to make different decisions regarding the type of maintenance activities, best vendor selection and different ways of knowledge transfer. There are different types of maintenance activities. The maintenance activities are selected based on the contract of the project [12].

The stakeholder involved in OSMO are located at different geographical locations may have to face issues related to culture mismatch and country-based advantages and disadvantages. Every vendor claims to the potential customer that he is an optimal option for him. The best vendor selection with clearly defined roles and responsibilities is a big challenge [13, 14, 15]. Knowledge management is also a critical part of the OSMO process. The stakeholders have to decide and select the best way to transfer and manage the knowledge between them [16].

Proposal assessment:

Before accepting the business offer of a client, the vendor (third-party maintainer) needs to know about the nature of the required job; what and how much resources and efforts are required to complete this job as different types of maintenance require different types of effort estimation. The customer's attitude, organizational culture, the complexity of legacy systems, number of functions and lines of code in a program can also be dominant factors in the mind of a vendor while accepting any business offer from any client [17, 18, 19, 20, 21, 22,23,24]. The vendor should consider other indirect factors [64] which can influence the business domain.

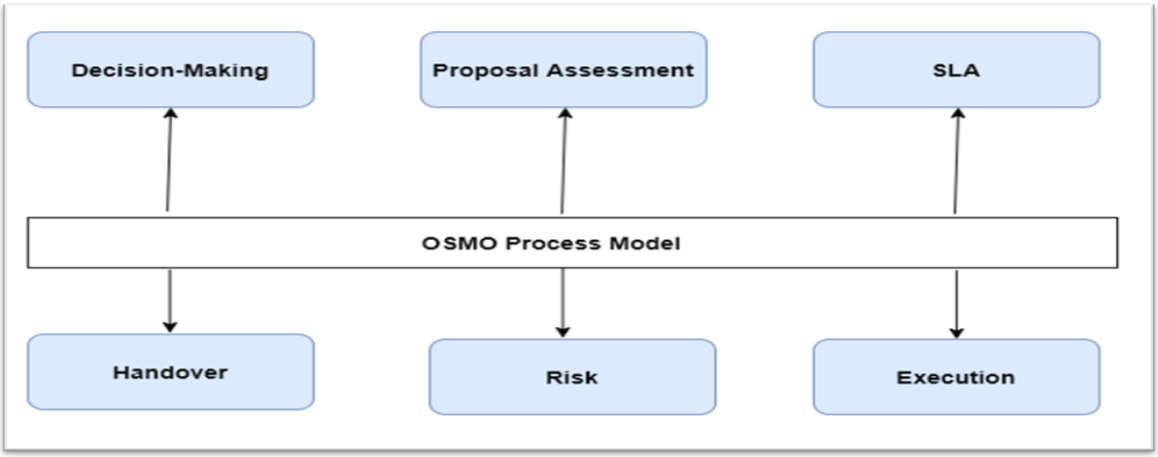

Fig. 1 Proposed OSMO process model

Service Level Agreement (SLA):

Service level agreement (SLA) has legal importance both for vendor and client. Research shows that in many of the cases client can't clearly describe what services are required to him [24]. It is not enough to just claim about required services but it is also important to mention the termination of these services, involved legalities [25, 26] and the roles and responsibilities of stakeholders involved [13].

Handover:

Handover or transfer is a critical process. The challenges involved in the handover process include the transfer of knowledge, experience, responsibilities, and documentation [27, 28]. The study [29] have discussed

onshore software system handover activities and challenges but offshore or global context is still to be explored.

Execution:

Execution is the phase when the maintainer is performing the required type of maintenance. This phase also faces challenges like knowing weaknesses and strengths of processes and products which are currently executing, to identify most likely activities and having a strategy to integrate overall activities of software maintenance process during execution phase [30,3, 31], management of documentation and code [32, 33] to know the impact of change requests on whole system [34] and to set the priority of change requests [35]. The vendor also has to find a way to quickly fix the problem [36] as keeping in view the most important factor is user satisfaction [37].

Risk:

It is hard to ignore risk factors during OSMO especially when it is occurring between different countries or time zones. Risk related challenges include risk analysis and its mitigation [38], inexperienced stakeholders, interdependencies of activities, uncertainty in contracts, uncertainty in legal environments, unstable (financial context) supplier, task complexity, uncertainty in efforts estimation and unclear scope of required services, etc [39].

7. Proposed Research Methodology

The proposed research work will be a combination of qualitative and quantitative research methods. The research process comprises of five phases. These phases are (i) Feasibility Study and Problem Definition (ii) Development of Proposed OSMO process model (iii) Validation of the OSMO process model in the IT industry with the help of suitable machine learning technique (iv) Validation of OSMO proposed model, concerning to research objectives, through expert judgment (v) Validation of OSMO proposed model through customized tool.

The complete representation of the research methodology is given in Figure 2.

Phase 1: Feasibility Study and Problem Definition

During phase 1, Ph.D. topic was selected after an informal survey conducted in both academia and industry. It guided that OSMO is a critical issue, and it needs to be investigated further. So, the topic is finalized as "An Offshore Software Maintenance Outsourcing Process Model".

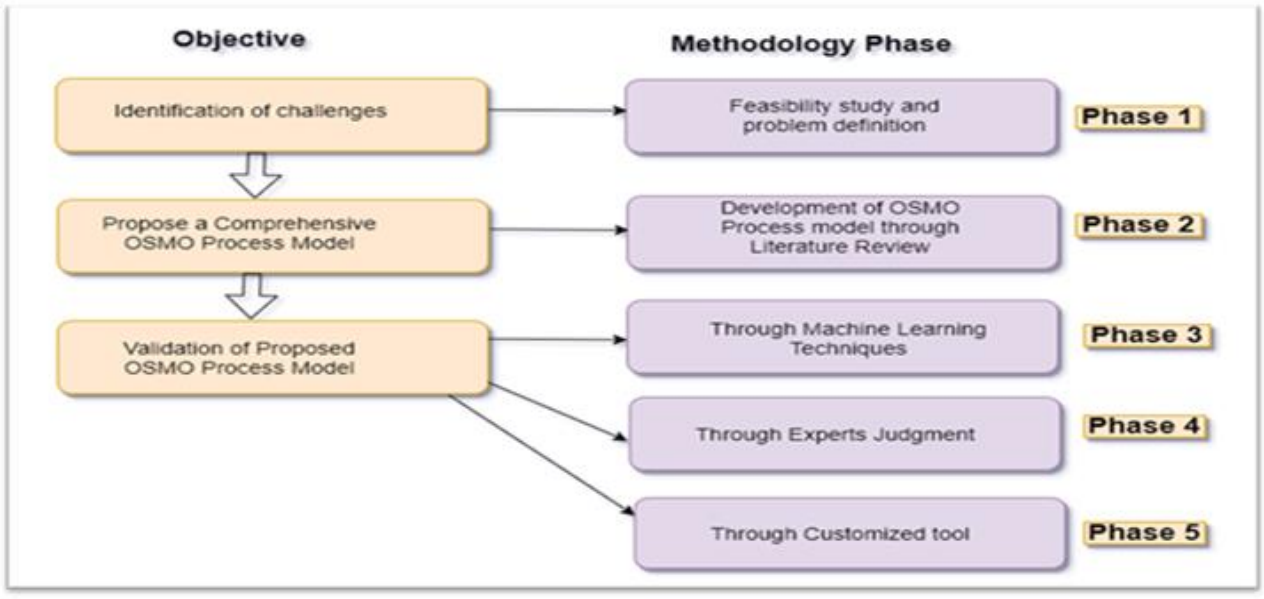

Fig. 2 Research Methodology

Phase 2: Development of Proposed OSMO process model

Phase 2, will be about the development of the OSMO Process Model through the literature review. The goal is to find more details of (a) current challenges faced by involved stakeholders in the OSMO process and (b) existing solutions or models in the domain of OSMO. In this research, different keywords will be used like software maintenance outsourcing, global software maintenance outsourcing, distributed soft-ware maintenance outsourcing, offshore software maintenance outsourcing, third party software maintenance outsourcing. To conduct this literature review, major databases (like IEEE Explorer, JSTOR, Emerald, ScienceDirect, and others) will be used.
This OSMO process model will be based on the findings of the literature review. The coding technique will be applied for the categorization or mapping of information extracted from the literature review [40]. The research will follow three steps in the coding process. These steps are (1) Organizing data, (2) Discovering patterns and (3) Categorization.
In the first step "Organizing data", activities related to OSMO from the literature will be extracted and placed in tabular form. To ensure data traceability, there will be complete references of data sources along with the extracted text. In the second step "Discovering patterns", the text segment will be labeled with the code name. While assigning the code label, research will ensure that the code label summarizes the essence of the text segment. In the third step "Categorization", activities serving the same purpose in different categories will be arranged. We will label each category as a practice. Each practice will be comprised of activities and sub-activities. The output of phase 2 will be a process model for OSMO.

Phase 3: Validation of Proposed Model through Expert Judgment

Phase 3 of this research work will be related to the validation of the OSMO process model through expert judgment. Industrial experts will validate the OSMO process model. It will also provide feedback about the relevance of the proposed model as per industry problems and its requirements. The case study-based research methodology will be used to conduct this phase. The small, medium and large-sized companies related to the IT industry will be included. So that the research can cross-examine the enactment of the OSMO process concerning the size of the IT industry. The selected organizations may belong to different domains. The study will also observe how the selected IT industry executes its OSMO process and faces different challenges. The study will keenly observe all elements of the OSMO process model like sequence of activities, sub-activities, step, task, pre and post conditions, work products, roles to perform activities, process owner, process engineer, constraints, etc.

Phase 4: Validation of Proposed Model concerning Prediction (Risk Mitigation)

Phase 4 of this research work will be related to validating this proposed model through the use of some suitable machine learning techniques like Naïve Bayes, Bayesian, Random Forest, etc. Different attributes or factors will be taken into account while making a prediction. It will help OSMO stakeholder to decide the appropriate project or vendor selection. Hence, it will reduce the potential risk involved in OSMO activities.

Phase 5: Case Study; Design of a tool for OSMO stakeholder

The case study will be related to the design and implementation of a tool for OSMO vendors. The designed tool will be customized as per the requirements of the OSMO vendor. The designed tool will have a user-friendly graphical user interface (GUI). In this tool, the client or vendor will select the options from the given list boxes on the given specific web form. Once all applicable selections have been selected, the tool will process this data and will give its output. The generated output will guide the client or vendor about the selection of the project. It will help both client and vendor in the prediction process.

8. Conclusion and expected results

The main contribution of this research is the preliminary version of an OSMO process model. The proposed OSMO process model consists of six clusters. Each cluster will contain elements of process models like activities, roles, guidelines, work products, and tools. The proposed model will be considered successful if it helps OSMO stakeholders to meet the challenges (mentioned in the Introduction section) from decision making to risk mitigation. The proposed model will be validated through artificial intelligence (machine learning techniques) and it will help OSMO stakeholders to reduce the potential risk involved in OSMO. This research will also provide a user-friendly graphical user interface (GUI) based tool. This prediction-based tool will help the OSMO vendor in the right project selection.

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Atif Ikram is currently doing his Ph.D. Computer Science from the School of Informatics and Applied Mathematics, Universiti Malaysia Terengganu, Malaysia. He joined CS&IT department of The University of Lahore, Lahore, Pakistan in 2010 and now working as Assistant Professor. His research area includes Software Engineering, Software Estimation, Machine Learning, Data Science. Email Contact: atif.ikram@cs.uol.edu.pk, p4086@pps.umt.edu.my

Dr. Masita Abdul Jalil is currently working as a Senior Lecturer in the School of Informatics and Applied Mathematics, Universiti Malaysia Terengganu, Kuala Terengganu, Terengganu, Malaysia. She is Chairman of the Bachelor of Computer Science (Software Engineering). Her interest is in the field of Software Engineering, Computer Science Education, Programming Languages and Mobile Learning.

Dr. Amir Bin Ngah earned his Ph.D. degree from Durham (UK). He is Chairman of Bachelor of Computer Science with Maritime Informatics, at the School of Informatics and Applied Mathematics, Universiti Malaysia Terengganu, Kuala Terengganu, Terengganu, Malaysia. His research interests include Software Engineering, Software Testing, Regression Testing, Software Maintenance, Program Analysis, Program Slicing

Dr. Ahmad Salman Khan earned his Ph.D. in Computer and Systems Sciences from The Royal Institute of Technology (KTH), Sweden in 2013. He is working as Assistant Professor at the Department of Software Engineering, The University of Lahore, Pakistan. His research expertise lies in the domain of software engineering. His research interest includes the engineering of industrial processes with a focus on software maintenance