# CRITICAL FACTORS IN SELECTION OF OFFSHORE SOFTWARE MAINTENANCE OUTSOURCING VENDOR

# A SYSTEMATIC LITERATURE REVIEW

**[1,2]ATIF IKRAM, [1]MASITA ABDUL JALIL, [1]AMIR BIN NGAH, [3]AHMAD SALMAN KHAN**

[1]School of Informatics and Applied Mathematics, Universiti Malaysia Terengganu, Malaysia

[2]Department of CS&IT, [3]Department of Software Engineering, The University of Lahore, Pakistan

E-mail:  aikram4u@gmail.com, atif.ikram@cs.uol.edu.pk , p4086@pps.umt.edu.my

**ABSTRACT**

Offshore software maintenance outsourcing (OSMO) is a Global Software Engineering (GSE) paradigm for maintaining high-quality software at very low cost in low-paid countries. From high-paid countries, the client organization contracts out whole software or part of the software maintenance to low-paid countries intending to save money. The main objective of this study is to identify important factors for a client when deciding about the selection of suitable vendors for OSMO. The identification of these factors will make the decision-making process easier for a client to select an appropriate vendor. This paper not only identifies critical factors which are important for OSMO clients but also identifies elements of a process like roles, work product, method and tools in the OSMO context. These elements will help and guide us towards the decision-making process. The research method used to conduct this study is systematic literature review (SLR). The studies included in the SLR were published in the year 2006 to the year 2019. Out of 47 studies, 18 were concerned with the designed research questions. The SLR found 13 critical factors, 13 assessment activities, roles, guidelines, work products, and tools related to the questions. Client organizations can use this information in the decision-making process to select a suitable vendor for successful OSMO.

**Keywords:** *Offshore software, Maintenance outsourcing, Critical factors, Decision-Making, Systematic Literature Review, Vendor selection*

## 1. INTRODUCTION

Software maintenance outsourcing (SMO) is a process in which an organization subcontracts software maintenance related service to a third-party (vendor). The term SMO is different from the term software development outsourcing (SDO) because of its scope. The scope of the term SMO also covers outsourcing of code maintenance, feature enhancement, bug fixing, software upgrade, version control, auditing, testing, software optimization, GUI enhancement, etc. [1]. The software maintenance outsourcing can be categorized into two major types, (i) Onshore SMO and (ii) Offshore SMO. Offshore SMO is concerned with obtaining maintenance service from outside of the geographical boundary of a country. One of the major challenges of OSMO is selection of vendor organization. Although, few researchers have discussed the challenges and criteria to decide and select an appropriate vendor for SMO but no comprehensive work exists in the domain of offshore software maintenance outsourcing.

The current research not only explains factors but also activities, roles, guidelines which are used by a client to select an appropriate vendor for offshore software maintenance outsourcing. By understanding these criteria, any client will be able to decide about the selection of appropriate vendor in a better way. It will not only lead to a long-term relationship between vendors and clients but will also help in the effective outcome of software maintenance outsourcing projects. The software maintenance phase is an expensive and the longest phase of the software development lifecycle as it consumes about 70% of the total software lifecycle cost [2,3]. The term outsourcing is used when a client contracts some vendor(s) to obtain services like maintenance operation, data entry, telecommunication services, goods, etc [4].

SMO is a phenomenon in which a third party subcontracts software maintenance related services or activities, at any level [5]. The companies from developed countries outsource their software maintenance and related activities to low wage countries to avail good maintenance services at low

cost, save time to focus on their core competences and research on new products [1,6]. This trend of outsourcing is increasing over time [1,7]. However, in addition to these benefits of outsourcing, there are different challenges and risks for SMO clients and vendors [8].

Although software maintenance is the longest phase of the software lifecycle, yet little empirical research work has been conducted related to offshore software maintenance outsourcing (OSMO). Unlike most of other studies [1,9,10,11] that focusing on SMO, the current study sets its scope only towards OSMO.

To gain an in-depth detailed review about OSMO process, the current research is based on the following research questions:

RQ1. What factors are important for a client during the decision-making process to select a suitable vendor in OSMO context?

RQ2. What elements of a process (like guidelines, roles, work products, tools) are used by client organizations during the decision-making process to select a suitable vendor in OSMO context?

The main purpose of the paper is to help OSMO client in the selection of an appropriate OSMO vendor. This purpose is achieved through the research question one (RQ1).

The paper provides a base to establish a process by identifying activities, roles, work products, guidelines and tools. Because all of these can be considered as elements of any process. The paper does not provide any complete and comprehensive software process model.

The remaining paper is organized in such a way that; Section 2 gives the background of the research, Section 3 describes the research methodology, Section 4 presents the results of a systematic literature review, Section 5 is discussion and Section 6 concludes the paper along with identifying the limitations.

## 2. BACKGROUND AND MOTIVATION

Software maintenance outsourcing is a contractual relationship between a client and a vendor organization to get high level software maintenance from the vendor organization at a low cost. If software development has been heavily outsourced to a vendor(s), then the same vendor(s) is a good choice for outsourcing [1].

The motivation behind this study is to facilitate OSMO clients in the decision-making phase, in which the client organization has to select the best vendor for its OSMO.

Software maintenance outsourcing is not risk free and facing many challenges. Different studies focus on the risks faced by client organizations during the software outsourcing process. Miller [12] emphasized the decision-making about the outsourcing of maintenance and development services. Krancher and Sturmer [13] on the other hand emphasized the importance of the decision-making phase for a client to select the appropriate vendor(s). Krancher and Sturmer [13] argued that during the decision-making phase clients should consider different factors like size of project, time duration, level experience, knowledge, technology involved, etc. Although the study highlighted these factors, no process or methods on decision-making in OSMO were presented.

Williams and Durst [14] also discuss the decisions-making during offshore outsourcing of an information system. Williams and Durst [14] more focused on decisions taken during the transition phase. Our literature search discloses that no prominent SLR has been conducted so far to find out the decision-making related issues in the field of OSMO from a client's perspective to select an appropriate vendor.

The current study adopted SLR to gauge factors that can help a client to make a correct decision about OSMO vendor's selection. This study will also find out OSMO decision-making related practices, roles, work products, and methods. These identifications will assist client organizations in the selection of appropriate and more suitable vendor (s) in the context of OSMO.

## 3. RESEARCH METHODOLGY

The research method used in this study is SLR since it provides a mean in interpreting and evaluating all possible research, under the research question(s) [15]. Systematic literature review (SLR) is different from other common literature surveys as it systematically follows evaluated decorum. It attempts to find out the most relevant published research material, about given research question(s) with the help of pre-defined research strings. After that, analysis is performed on collected research
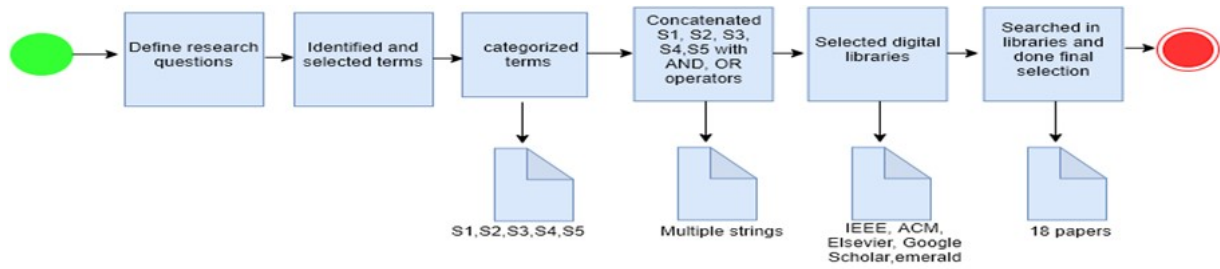
*Figure 1: SLR    Process*

material by using predefined exclusion/inclusion criteria. The SLR process is shown in Figure 1.

### 3.1. Construction of research strings

The strings used in this research are given in Table 1. The strings are categorized under five columns from S1 to S5. These columns contain keywords along with relevant synonyms in the context of research questions. The complete search strings to search out published literature were made by the concatenation of these columns with operators 'AND', 'OR'.

### 3.2. Inclusion and Exclusion criteria

This research has used the following inclusion and exclusion criteria.

Inclusion criteria:

This section describes the criteria used to include the literature (technical report, research articles, expert opinion, etc.) in this study for data extraction purposes. The criteria are as follows:

• Peer reviewed studies, written in the English language only

• Studies that describe factors involved during vendor selection in OSMO

• Studies that describe risk factors involved during vendor selection in OSMO

• Studies that define challenges faced by client organization while selecting vendor(s) in OSMO

• Studies that define the relationship between OSMO and vendor

• Studies that define practices, roles, work product, methods and tools for the selection of a successful vendor in OSMO

• Studies that define vendor (supplier)'s capabilities for successful OSMO

Exclusion criteria:

This section describes the criteria used to exclude the literature (technical report, research articles, expert opinion, etc.) which was found through search terms. The criteria include:

• Studies other than English language

• Studies do not synchronize to research questions

• Studies do not cover offshore outsourcing context

*Table 1: Strings used in review papers*

| S1= string 1 | S2= string 2 | S3= string 3 | S4= string 4 | S5= string 5 |
|---|---|---|---|---|
| decision making | critical factors | offshore | software maintenance | outsourcing |
| supplier selection | challenges | global | software support | subcontracting |
| vendor selection | barriers | Multinational | Post-development | |
| | obstacles | International | | |
| | risks | worldwide | | |

• Studies do not mention decision making in OSMO

• Studies which do not describe factors challenges important for client organization while selecting a suitable vendor in the OSMO context.

3.3. Literature search and selection

The study used different digital libraries to search for the relevant literature. These libraries include Springer link, ACM, ScienceDirect, Google Scholar, IEEE Explore and CiteSeer. Only such literatures were selected which fulfills inclusion criteria. Initially, during the primary selection, 47 literatures were found. After applying inclusion /exclusion criteria and reading the text thoroughly, 18 papers were finally selected as per the requirements of research question 1 (RQ1) and research question 2 (RQ2). The details of the final selected papers are given in the Appendix.

**4. RESULTS**
This section shows the results related to the aforementioned RQ1 and RQ2. Although there

are several papers found in the literature related to SDO and a handful related to SMO but there exists a very small number of papers that are directly related to OSMO. This kind of result shows that SMO, especially in the offshore context needs more attention. After securitizing, we finally found 18 papers which are related to our research questions in one way or another. These papers belong to 4 famous digital libraries, as shown in Table 2.

Table 3 summarizes the 14 critical factors which can play an important role in the selection of OSMO vendor. These 14 critical factors were found as a result of RQ1, "What factors are important for a client during the decision-making process to select a suitable vendor in OSMO context?" already mentioned in Section 1. Table 3 shows that 7 out of 14 factors received much attention from OSMO clients. The most important factor is cost saving, while others include risk, reliability, contract conformance, stability, quality, and communication. These factors are ordered in Table 3 according to their importance to the OSMO client.

*Table 2: Distribution of selected papers*

| No | Digital library | Final selection |
|----|----------------|-----------------|
| 1 | ACM | 2 |
| 2 | Elsevier | 4 |
| 3 | IEEE Explorer | 5 |
| 4 | Google Scholar | 7 |
| | Total | 18 |

*Table 3: Critical factors in OSMO vendor selection*

| No | Critical factor | Reference of relevant papers | Total |
|----|----------------|------------------------------|-------|
| 1 | Cost Saving | 1,2,3,4,5,8,9,10,11,12,13,14,15,17,18 | 15 |
| 2 | Risk | 1,2,3,7,8,9,10,11,13, 14,15,16,17 | 13 |
| 3 | Reliability | 1,3,4,9,10,12,13,15,16,18 | 10 |
| 4 | Contract conformance | 1,3,4,10,13,15,16,17,18 | 9 |
| 5 | Stability | 2,3,7,9,11,13,15,17 | 8 |
| 6 | Quality | 3,4,9,10,12, 15,16,18 | 8 |
| 7 | Communication | 1,4,7,11,13, 14,15,17 | 8 |
| 8 | Culture | 1,2,3,9,10,11,15 | 7 |
| 9 | Knowledge management | 3, 5,7,11,15,16 | 6 |
| 10 | Legal | 3,6,10,13,15,17 | 6 |
| 11 | Capability and Technical infrastructure | 1,3,9,10,15 | 5 |
| 12 | Availability of help desk | 3,6,7,9,10 | 5 |
| 13 | Response time | 3,6,10,16,18 | 5 |
| 14 | Tools automation | 3,4,6,9,10 | 5 |

These factors are important to the client during the decision-making process to select a suitable vendor in OSMO context. The complete list of references of published articles which favors these critical factors can be found in the Appendix.

The data in Table 3 shows the frequency of identified critical factors in the selected papers.

The most frequent critical factor in selected papers is "Cost Saving" factor with 83 % frequencies (mentioned in 15 out of 18 selected papers). The second factor is the "Risk" factor with 72% frequencies (mentioned in 13 out of the total 18 selected papers). This result suggests that the client should take into account "cost saving" and "risk" factors while making any decision selection of OSMO vendor. Table 3 illustrates the frequencies of the other 12 critical factors which important in OSMO vendor selection.
The first critical factor is cost saving. This factor received the most frequency of references among other factors. Thus, it shows its importance in the OSMO vendor selection. Every OSMO client needs such a vendor that provide maintenance services on cost effective terms and conditions.

The next critical factor involved in the selection of OSMO vendor is the risk factor. This risk factor is associated in different domains like cost and time over run, security, IP rights, portability and compatibility, vague contracts, knowledge, and stability related risks. The result indicates that OSMO clients should take into account these risks while deciding on the selection of OSMO vendor [1,2,3,7,8,9,10,11,13, 14,15,16,17].

The next factor is reliability. The OSMO client should find a reliable vendor to outsource his software maintenance. The vendor must be punctual and should have a good record in meeting the deadlines [1,3,4,9,10,12,13,15,16,18]. This factor is followed by contract conformance. The OSMO vendor should have a good reputation to understand and fulfil the client's requirements [1,3,4,10,13,15,16,17,18].

Stability plays an important role in the success of any outsourcing project. The OSMO client should realize that the stability of a vendor's country and the stability of the vendor's organization, are both important. The client should select some stable vendors for his outsourcing services [2,3,7,9,11,13,15,17].

Regarding quality factor, the client should select such vendor which can accomplish the user's requirements [1, 4, 7, 11, 13, 14, 15,17]. Successful OSMO is not possible without effective communication. If there is any communication problem then successful execution of outsourcing will be very difficult. The vendor should have good communication setup, along with any informal communication channel with the client organization [1,4,7,11,13, 14,15,17].

Cultural difference is a huge barrier between parties participating in OSMO. As, this business is executing among two different countries, so there are more chances of culture clash. The client should have an understanding of the pros and cons of vendor's culture. Both in communication and culture, OSMO client should focus on differences in the official used language. If there is a language barrier, then it would be very hard to understand the exact requirements [1,2,3,9,10,11,15].

Knowledge sharing between client and vendor organizations is necessary for the successful execution of OSMO. The client should assess the expertise of the vendor in sharing and handling knowledge in offshore projects [3, 5,7,11,15,16].

Every country has its legal framework. Client organizations must have exact information of the legal issues at the vendor side. The OSMO client must know about the legal position of the vendor's company and the legal requirements of the vendor's country [3,6,10,13,15,17].

The vendor organization can't provide effective OSMO in the absence of capability and technical infrastructure. The client should select such a vendor who has skilled human resources and required technical infrastructure [1,3,9,10,15]. There should be a single point of contact in the form of a help desk at the vendor side [3,6,7,9,10]. The vendor must be available as per the client's office timings [3,6,7,9,10].

The second last factor is response time. The vendor should be quick in responding and solving to client's queries [3,6,10,16,18]. The last factor is tools automation. The use of tools in software testing and requirements prioritization makes these processes more effective and accurate [3,4,6,9,10]. The OSMO client should consider these discussed factors to find a suitable vendor, especially in an offshore context.

The next research question RQ2, "What elements of a process (like guidelines, roles, work products, tools) are used by client organizations during the decision-making process to select a

suitable vendor in OSMO context?" was mentioned in Section 1. Table 4 shows the results obtained for RQ2, which explains the different roles, guidelines, work products and tools which are important to the OSMO vendor selection process. The client organization can select appropriate OSMO vendor by using this information. This information will help the client during the decision-making process of OSMO vendor selection. For example, there is a guideline that the client should assess the vendor's specialties in automated testing. It is a well known fact that regression testing is an important activity in software maintenance [16]. Hence, OSMO client must keenly assess potential vendor's expertise about tool usage in regression testing. Similarly, OSMO client can use information mentioned under work product in Table 4. The OSMO client should assess its potential vendor concerning these mentioned documents e.g. change management report. The software maintenance process faces a lot of change requirements. Therefore, a vendor with poor change management might not be a good candidate for OSMO. Similarly, a vendor with

incompetency in software cost estimation will not be a good selection for OSMO. Overall, the OSMO client can assess its potential vendor better by using the information mentioned under four elements of the decision-making process. This exercise will help OSMO client to find the most suitable OSMO vendor.

Table 5 presents activities which are important for OSMO client. These activities are extracted from Table 3 and Table 4. The activities are not listed according to importance or priorities. Thus, any OSMO client can use any of these activities as per outsourcing situations. The client should exercise or dry run these activities before making any final decision regarding the selection of OSMO vendor. These activities can assist OSMO clients in the decision-making process to select an appropriate vendor for OSMO.

*Table 4: Elements of the decision-making process*

| Element | Extracted Information | References (from Appendix) |
|---|---|---|
| Role | Knowledge controller, maintenance programmer, trouble shooters, maintenance engineer, support engineer, offshore team leader, offshore engineer, manager contracts, transition manager, operations manager, offshore IT director | 5,6,10,11,14,16 |
| Guideline | Client should assess the ability of knowledge controller. There should be a metric database to check code size and complexity. Client should assess vendor's specialties in automated testing. Client should prioritize its contract clauses instead of vendor's clauses. | 5,6,17 |
| Work product | Error reports, Problem management report, change management report, configuration management report, quality management report, maintenance cost estimation report, Task tracking sheet, system test specification, vendor agreement, business plan, service level agreement | 4,6,14,17 |
| Tool | Regression testing tools, reverse engineering tool, code auditor, cost estimation tool, refactoring tool, Informal tools for communication like Skype, Microsoft Netmeeting, automated tools for optimal vendor selection | 4,6,10 |

*Table 5: Important activities during the decision-making process of vendor selection*

| No | Activities to be assessed in OSMO context |
|---|---|
| DM1 | Assess potential vendor's company state of stability |
| DM 2 | Assess potential vendor's reputation to meet deadlines |
| DM 3 | Assess potential vendor's contract conformance history |
| DM 4 | Assess potential vendor and your common working hours |
| DM 5 | Assess potential vendor's cultural similarities and differences |
| DM 6 | Assess the potential vendor's expertise in officially used language |
| DM 7 | Assess potential vendor's cost estimation accuracy. It should be realistic |
| DM 8 | Assess potential vendor's expertise in knowledge transfer and management |
| DM 9 | Assess potential vendor's communication expertise and quality of infrastructure |
| DM 10 | Assess potential vendor's company legal state of affairs. It should not be black listed |
| DM 11 | Assess potential vendor's reputation about IP rights, data confidentiality, data security |
| DM 12 | Assess potential vendor's human resources turnover ratio. If staff is leaving frequently then it is risky. |
| DM 13 | Assess potential vendor's job description and definition of roles in his organization. Proper roles should be defined. |

## 5. DISCUSSION

This study has found 14 critical factors and 13 activities which are important for an OSMO vendor. The vendor can increase the probability to be a successful OSMO vendor by following these factors and activities. Simultaneously, an OSMO client can increase the probability to select a better OSMO vendor through these factors and activities.

The most critical factor, among these fifteen factors, is the cost saving. Obviously, every client wants a quality software product at reasonable cost. The cost-effectiveness is the primary motivation for software outsourcing. So, if a client ignores this fact and selects such an OSMO vendor that cannot save cost then the primary motivation for software outsourcing 'cost-effectiveness' is failed. Therefore, a client must focus on cost saving factor while selecting an OSMO vendor.

The next critical factor is 'risk' factor. Because risks are painfully real and common in software outsourcing process, it's critically important that client should work hard to mitigate such risk which can threaten the OSMO success.

The next factor is reliability. The OSMO client should select such a reliable vendor that can deliver good services on time. A vendor with large organization can be a good choice, because if something goes wrong, even then such large organization can deliver the right services on time. It is important to have best suitable vendor for smooth execution of OSMO process.

The software contract is as important as the contract of any tangible product. The software contract is the most critical and legal document. It is inevitable for OSMO client to have a good software contract. In contract the OSMO client should focus on points like warranties & liabilities, IP (intellectual property) rights issue, ownership of software code, support time and terms etc. If OSMO client ignores such points and signs a weak contract then client's organization will defiantly face difficulties while proceeding further in outsourcing process.

The next factor is stability. Only a stable vendor can make sure the delivery of OSMO services on time. The OSMO client should select such OSMO vendor which has stable organization in a politically stable country. If stability is an issue for OSMO vendor then it's very hard that such organization can provide services to OSMO client on time.

No one wants to compromise on quality. If the software is not working as per client's requirements then it is of no use. Therefore, OSMO client should select only such OSMO vendor which has good reputation to fulfill client's requirements.

A good mechanism for effective communication is mandatory in software services domain, especially when it is executed in offshore context. The OSMO client should select such OSMO vendor who has skilled resources, quick response time and latest infrastructure for effective communication. The poor or ineffective communication will lead the OSMO client to business loss. The OSMO client

should also check the knowledge sharing abilities of OSMO vendor through effective communication system. If vendor is not skilled to share knowledge then the smooth execution of OSMO process is very difficult in offshore outsourcing context.

Different countries have different legalities about a same matter. For example, in most of western countries, anyone can criticize on any religion but in most of Islamic countries, it is illegal to do the same. Therefore, for uninterrupted execution of outsourcing, the OSMO client must have accurate and updated information about the OSMO vendor's individual legal position as well as rules of the OSMO vendor belonging country.

The current study has figured out 13 important activities (Table 5). These activities are of great use for the OSMO client. The OSMO client can increase the probability to have a better OSMO vendor by implementing these activities.

### 6- CONCLUSION

The existing literature mainly focus on SMO and missing the offshore context. The current study enhanced the existing knowledge by adding the offshore context in the domain of software maintenance outsourcing. The current study has identified factors, activities, roles, guidelines, work products and tools which can be used in OSMO process. The OSMO client can use these elements to find an appropriate OSMO vendor. Simultaneously, by adopting these elements, the OSMO vendor can boost the chances to be selected as a successful OSMO vendor.

The study has limitations as well. Although the study has identified elements of a process but has not given any complete process model for OSMO. The current research work can lead towards a comprehensive process model for OSMO.

The combination of machine learning techniques with this work can make this work more useful. The 14 factors found in this paper, with the help of some machine learning techniques, can be used to assess and select an appropriate OSMO vendor.

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