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CRITICAL SUCCESS FACTORS FOR PORTFOLIO COST MANAGEMENT IN OFFSHORE SOFTWARE DEVELOPMENT OUTSOURCING RELATIONSHIP FROM VENDOR'S PERSPECTIVE: ANALYSIS BASED ON ORGANIZATION TYPE USING SYSTEMATIC LITERATURE REVIEW

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ABSTRACT: *Offshore Software Development Outsourcing (OSDO) is increasingly becoming the normal practice in the software industry. It offers a bundle of core benefits for client organizations which includes: high quality, fast and cost effective development of software products. However, OSDO possesses substantial risks and limitations during project management. To handle such problems Portfolio Cost Management (PCM) is used one of the best approaches. It is a set of centralized management of processes, methods and technologies used between client and vendor to reduce software costs and improve quality. We have performed a Systematic Literature Review (SLR) by applying customized search strings obtained from our research questions, along with the other SLR steps such as protocol development, initial publication selection, final publication selection, publication quality assessment, data extraction process and data synthesis. In this research, we explore 16 success factors of PCM to analyze the association between a client and vendor. It includes: 'efficient cost estimation strategies', 'efficient project management', 'efficient knowledge sharing management', 'efficient software effort estimation', 'planning realistic goals', and nine others. Furthermore, we analyze these factors based on different types of organizations, i.e. research and non-research. For best results in the software industry, it is proposed for vendor organizations to address the factors: 'efficient cost estimation strategies', 'efficient project management', 'efficient knowledge sharing management', 'efficient software effort estimation' and 'planning realistic goals'.*

Keywords*: Portfolio Cost Management; Offshore Software Development Outsourcing Relationships; Global Software Development; Systematic Literature Review.*

1. Introduction. It is documented that globalization process has affected every industry including Software Engineering (SE) in the form of Global Software Development (GSD) [1]. GSD has become the normal practice in SE due to its fruitful outcome and smart development of software products. GSD is the situation in which software development teams are distributed across the boundaries of a region [2]. GSD

behaves like a big umbrella, where Offshore Software Development Outsourcing (OSDO) is a term under this umbrella. OSDO is a relationship between two parties i.e. client and vendor organizations. In OSDO relationships client organizations contract out all or part of its software development activities to a vendor organization, who provide agreed services for remuneration [3]. Client organizations benefit from offshore outsourcing because vendors in developing countries (offshore vendors) charge them one-third less than onshore vendors [4]. Thus client organizations are highly motivated to consult the services of vendor organizations for the attractive benefits to increase the value of an organization's business strategy.

Many reasons drove OSDO practice rise, where reducing development costs can be more highlighted [5]. OSDO enables organizations to abstract themselves from geographical distances, while having qualified work force and minimizing cost, thus increasing the market area by producing software(s) for remote clients and obtaining a longer workday by taking advantage of time differences [2, 6]. The nature of OSDO allows development work to be sub-divided into modules, which may be developed in parallel across multiple globally distributed sites thus leading to improved cycle time [7]. Besides the long-term benefits of practicing OSDO, it also poses substantial risks for both client and vendor organizations including poor project management. Various countries are practicing offshore outsourcing strategy. Now a days India is known as a leader in delivering high end software outsourcing services and they have increased their socio economics up to a high extent using this software development strategy [8, 9].

One of the key factors influencing software project success or failure is project management. When vendor organizations get contracts of many projects at a same time, then the proper management is a challenge for vendors. In this situation Project Portfolio Management (PPM) plays its significant role and is becoming a key competence for companies handling numerous projects simultaneously [10].

In PPM, projects are managed in a coordinated way to deliver benefits that would not be possible if the projects were managed independently [11]. PPM is the art and science of applying a set of knowledge, skills, tools, expertise and techniques to a collection of projects to meet or exceed the needs and expectations of an organization's investment strategy [12].

Portfolio Cost Management (PCM) is the situation where project manager is intended to manage the software development cost without affecting the quality. PCM aims to reduce software development costs and improve software quality. In this paper, we are intended to explore the factors that positively influence PCM in the situation of offshore software development outsourcing. To decide whether to bid for a contract, software cost estimation can provide a condition in PCM.

A critical activity in the initial project phases is the proper estimation of the necessary project development costs. Software cost estimation occurs before a project is started, when either the cost of the project must be estimated from the project description, given the available project budget [13]. Software cost estimation affects almost all activities of software project development such as; biding, planning and budgeting, more over the accurate estimation is very crucial to the success of the project [14]. The main software cost estimation methods are expert judgment, algorithmic cost estimation and estimation by analogy [15].

Inaccurate estimates are directly responsible for a great number of issues related to PCM, like low quality and lose of milestones. Typically a software development environment involved more than one project at a time, the available tools in the area of software cost estimation deals mostly with single software project [16]. Our long-term research goal is to introduce an effective Portfolio Cost Management Model (PCMM) to assist vendor organizations in assessing their software development cost estimation and management activities in a project portfolio environment.

2. Background and Motivation. In order to successfully design PCM initiatives in the context of OSDO, we need to be constantly aware of what really positively influence portfolio cost management process in terms of OSDO. It is important to discover what critical success factors will positively influence PCM process. As research shows that, half of the companies that have tried outsourcing have failed to realize the anticipated results [17]. The knowledge of these factors lead us to the development of a new and improved PCM approach, while the adoption of this approach will take an organization to the aimed peak in the software industry.

Literature shows that no SLR has applied to PCM in the context of OSDO and this is the motivation for the research reported in the paper. We have used a systematic approach and have identified sixteen success factors, which positively influence PCM in the situation of OSDO.

Project portfolio cost estimation and management is an indisputably important activities for the proper

planning, follow-up and control of projects, especially for large organizations while developing software intensive systems [18]. According to the recent research: the majority of the outsourced projects involving software development activities, suffer from budget and schedule overruns, caused among other reasons, by insufficient initial estimations [19]. Effort estimations are helpful for both IT developers as well as for IT clients, based on these estimations, the acquiring organization may assess and monitor implementation costs, evaluate bids and develop realistic budgets and schedule [20].

Estimating and predicting development cost of software project success is a well-researched area, but maintaining the ratio of sound precision is still a great challenge for project managers. In software project management one of the important issues is to effectively control the expensive investment of software development costs [21]. It is necessary to utilize various estimating techniques to effectively estimate software project cost within the information technology domain. In the shade of experience, it is always difficult for any generic software cost estimation technique to produce accurate statistics that are better than the target value of 25% when applied to some project data set [20]. The efficiency of a project state can be defined as the relationship of cost to its success probability, and the action of optimizing this relationship is equivalent to a multi-objective problem [22].

In order to effectively control the cost, the project managers must have to allocate the costs to the different phases of the software development life cycle. Factors which affect system development efforts directly or indirectly includes, size of the system, system complexity, team member capabilities, team experience and expertise, use of innovative tools and technologies, requirement instability and the software environment [23].

In order to produce accurate estimates and avoid large errors, several cost estimation techniques and models have been introduced like Constructive Cost Model (COCOMO) used to accurately calculate the amount of cost and time schedules for software projects. Improving the accuracy of cost estimation models available to project managers would facilitate more effective control of time schedules and budgets during software development. Software engineering economics approximates concepts from economics sciences and corporate finance theories to the software development context, supporting stakeholders like investors and managers who work in the software industry to make better decisions about their software projects increasing profits and minimizing losses [24]. As software development becomes an increasingly important enterprise in the industry, managerial requirements for cost estimation and management increase, yet we continue rather a long history of failing to cost software system development adequately.

3. Research Questions. To understand portfolio cost management in the situation of offshore software development outsourcing relationships, we have formulated the following research questions. While the first question is the basic one and belongs to the newly identified critical success factors and the other question belongs to the study of analysis of these success factors which will be entertained one after another in this paper.

RQ1: What are the critical success factors, as identified in the literature, to be addressed by vendor organizations that positively influence/assist portfolio cost management in the context of offshore software development outsourcing relationships?

RQ2: What is the association between the newly identified critical success factors with respect to the different types of organizations?

4. Methodology. For undertaking this research, a Systematic Literature Review (SLR) is used as the main approach for the data collection. The SLR is a structured and methodical way of identifying, assessing and analyzing all the available relevant published primary studies in order to investigate a specific research question. Systematic reviews are rigorous, formally planned and methodically executed, which makes it differ from ordinary literature surveys. Planning the review, conducting the review and reporting the review are the main phases of a systematic review [25]. A systematic review protocol was initially written to describe the plan for undertaking the review, this protocol describes all the planning steps with details [25]. Many of the latest research have been carried out using systematic reviews [26-29]. The major steps in our methodology are:

- Constructing a search strategy and then perform the search for relevant papers
- Perform study selection process

- Apply study quality assessments
- Data extraction process and analyzing/synthesizing the extracted data

Our search strategy is based on the following steps:

- Derive the major terms by identifying Population, Intervention and Outcome.
- Find the synonyms and similar words for these major terms.
- Verify these terms in relevant papers and academic databases.
- 'OR' operator is used to connect synonyms and similar spellings (if allowed in the concern database)
- 'AND' operator is used to connect major terms (if allowed in the concern database)

On the basis of the above search strategy, we have formulated the following search terms:

- POPULATION: offshore software development vendor organizations
- INTERVENTION: factors and characteristics
- OUTCOME OF RELEVANCE: best practices for PCM in the context of offshore software development outsourcing relationships, innovation in PCM
- EXPERIMENTAL DESIGN: empirical studies, exploratory studies, case studies, SLR's, theoretical studies and expert opinions

We applied our search terms in different numerous academic databases and found the potential relevance to the topic, shown by the following terms:

Project portfolio cost management: project portfolio management OR project portfolio charge management OR project portfolio price management OR project budget portfolio management OR project portfolio rate management.

Global software development: global software development OR GSD OR information system outsourcing OR information technology outsourcing OR software contracting-out OR distributed software development OR multi-site software development.

Success factors: factors OR drivers OR motivators OR elements OR parameters OR characteristics. After trial search(s) we have designed the following search strings:

(Project portfolio management OR project portfolio charge management OR project portfolio price management OR project budget portfolio management OR project portfolio rate management) AND (global software development OR GSD OR information system outsourcing OR information technology outsourcing OR software contracting-out OR distributed software development OR multi-site software development) AND (factors OR drivers OR motivators OR elements OR parameters OR characteristics)

Based on the available access and importance, the following digital libraries were used:

- IEEE Xplore; (http://www.ieeexplore.ieee.org)
- Science Direct; (http://www.sciencedirect.com)
- ACM Portal; (http://dl.acm.org)
- Springer Link; (http://link.springer.com)
- CiteSeer; (http://citeseerx.ist.psu.edu)

Note: Since these digital libraries vary from each other in their architecture, search mechanisms and capabilities, so we have tailored our search strings accordingly.

The following inclusion criteria were used after retrieving the relevant literature through these search strings:

- Studies that describe portfolio cost management from vendor's perspective
- Studies that describe the factors/motivators for portfolio cost management in the situation of offshore software development outsourcing
- Studies that describe offshore software development outsourcing with a focus on portfolio cost management
- Studies, which describe criteria for a successful portfolio cost management
- Studies that describe challenges, issues, barriers in portfolio cost management
- Studies that describe the factors affecting the continuation/termination of portfolio cost management

The following exclusion criteria were used:

- Studies that are not even relevant to the research questions
- Studies that do not describe offshore software development outsourcing with a focus on portfolio cost management

- Studies other than offshore software development outsourcing relationships
- Papers written in non-English are excluded
- Poor-English written papers are excluded as they lead to ambiguity
- Textbooks are excluded (printed/electronic)
- Master level thesis, graduation projects, and PhD dissertations are excluded

No compromise on quality leads to the anticipated results. For the purpose of measurement of quality, a quality assessment was done for any manuscript to pass the initial phase; quality assessment was performed after making a final selection of publications. The quality of papers was assessed in parallel at the time of data extraction. Three quality check lists were prepared as shown in Table 1.

Table 1. QUALITY ASSESSMENT

Criteria	Notes
Does the paper clearly state the findings and results?	Yes=1 No=0
Does the arguments well-presented and justified?	Yes=1 No=0
Does the paper well referenced?	Yes=1 No=0

We have identified and positioned our finally selected 50 papers in total, shown in Table 2, retrieved through our customized search strings, which meets our inclusion/exclusion criteria and quality assessment as well.

Table 2: DATA SOURCES

Resources	*Total results found*	*Initial selection*	*Final selection*
IEEE Xplore	125	31	16
Science Direct	90	40	8
ACM Portal	332	55	15
Cite Seer	930	36	3
Google Scholar	515	59	4
Springer Link	592	28	4
Total	2584	249	50

The review was undertaken in a team work. However the data extraction phase was completely performed by the principal author of the paper. In order to reduce author's bias, inter-rater reliability test was performed. The secondary reviewer randomly selected 6 publications from the list of papers already used in the data extraction by the primary reviewer and extracted independently. The results obtained were compared with the results produced by the primary reviewer and found insignificant differences. The following data were extracted from each of the papers chosen for the data extraction purpose: Paper S.no, Paper ID, Date of Review, Paper Title, Paper Authors, Reference, Database, Sample Population, Target Population, Publication Quality Description, Methodology/Study Strategy (i.e. Interview, Questionnaire survey, Case study, Survey), Organization Type (i.e. Research organization, Non-research organizations, Educational Organization), Organization Size (i.e. Small size, Medium size, Large size), Outsourcing Type (i.e. Offshore, Inshore, Near-shore, Global software development), Country/Location of the analysis and Year of the analysis.
After the data extraction phase a list of success factors/motivators were identified from the sample of these papers. Both primary and secondary reviewers performed the data synthesis thoroughly, in order to derive a list of categories to classify these newly identified success factors. Initially a list of 18 categories was identified. After a sound review, for clarity, some of the categories were merged together and finally obtained a list of 16 success factors, shown in Table 3.

5. Results and Discussions

5.1. **Critical success factors identified through systematic literature review**. In order to answer RQ1, Table 3 shows the list of critical success factors identified through SLR. We have identified a list of 16 success factors that play a very important role in portfolio cost management in the context of software

outsourcing relationships. 'Efficient cost estimation strategies' (80%) [23], is the most common success factors identified in our study.

- To effectively estimate project cost with in information technology domain, it is necessary to utilize various estimating strategies and techniques. In this regard the use of formal estimating models are positively related to the proper predictability of project cost [23].
- In addition for a software cost estimation strategy/method to be useful, it should produce sound estimates, accepted and trusted by the practitioner [30].

Our results indicate that 'efficient project management' (70%) is an important factor in the fruitful outcomes of OSDO projects in a portfolio environment. Efficient project management is the key factor in the success or failure of a software project. Over the last two decades many firms in the USA and UK have used to outsource their software projects to vendor organizations of other countries such as India, China, Russia, Pakistan and Malaysia. In vendor organizations one of the main reasons for software development outsourcing failures; is the lack of efficient project management. Different studies have described the impact of 'efficient project management':

- Best project management practices used by project managers can optimize software project cost estimation and management [23].
- Efficient software project management can leverage the beneficial effects of budget on schedule pressure in software development to gain more competitive advantage in the global market [31].
- One of the key factors influencing project success or failure is project management, an active project manager is able to improve their cost estimation accuracy by efficiently managing the outsourced projects [32].

In our study we have identified that 'efficient knowledge sharing management' (42%), contribute to the effective establishment of portfolio cost management activities in outsourced projects. Knowledge between the different stakeholders in the development team must be shared properly. In our studies different researchers have cited this factor:

- The development of cost estimates depends on the organizational knowledge sharing, moreover the authors also claims that project managers require the core competency to acquire, share and integrate organizational knowledge to accurately predict, estimate and manage IT projects costs [23].
- Establishment of an efficient communication and knowledge sharing mechanisms between the members of the organization allowing a developer to discover the status and changes made with in each project in a project portfolio [6].

60% of the articles in our research described 'efficient software efforts estimation'. The estimation of software efforts are the most important activity during project portfolio management. Therefore these efforts like cost, time, and workforce should be estimated properly and effectively, improving software cost estimation dramatically. A number of techniques are available to portfolio project managers for this purpose like artificial neural networks, algorithmic models and analogy based estimation.

- Cost and efforts estimation is used for protecting the head count in projects or organizational units or to ensure the continuation of a project, and does not consider the intentional estimate distortion [18].
- Software efforts estimation can be used for a number of purposes e.g. budgeting, tradeoff and risks analysis, project planning and control, and software process improvement analysis [33].

Our results also indicate that 'planning realistic goals' (18%) can get the vendor organizations to the peak of success. The planed goals and milestones must be achievable. The goals must be close enough to reality which could be accomplished in a timely manner. Our research suggest about this factor:

- The application of meaningful goal oriented measures significantly influence cost estimation [34].
- For a project manager who hopes to use the cost/schedule trade-off relationship for project planning, a plot of cost as a function of actual not scheduled completion time is more useful [35].

Thirty percent of our selected literature describes 'realistic co-relation between software cost and quality' is one of the main factors in portfolio cost management. Most of the time the software developers tries to provide high quality software with minimal cost, but sometime it goes wrong and as a result the quality suffered by minimizing the software costs. Understanding and controlling software qualities, relates to the management of software costs. So a realistic co-relation between cost and quality is crucial. Various studies have described the impact of realistic co-relation between software cost and quality:

- A project which tries to simultaneously reduce software cost and improves software quality can do so by intelligent and cost effective use of modern software techniques [36].
- The vendor organizations must have aim to reduce software cost and improves productivity and quality on software development [37].
- Software quality plays an important role in determining service costs for more mature products [38].

We have also identified several other factors that have a positive influence on vendor organizations in portfolio cost management in the situation of offshore software outsourcing as publicized in Table 3 (RQ1).

Table 3: SUCCESS FACTORS FOR PCM IDENTIFIED THROUGH SLR

S.No	Success Factors	Total Frequency in SLR (n=50)	Percentage
1	Efficient Cost Estimation Strategies	40	80%
2	Efficient Project Management	35	70%
3	Efficient Knowledge Sharing Management	21	42%
4	Efficient Contract Management	4	8%
5	Realistic Co-relation between Cost and Quality	15	30%
6	Design & Development Concise Coding	10	20%
7	Cost Sourcing	7	14%
8	Efficient Resource Allocation & Management	8	16%
9	Efficient Software Efforts Estimation	30	60%
10	Mechanisms for Error Prediction	2	4%
11	Planning Realistic Goals	9	18%
12	Project Post-mortem Analysis	9	18%
13	Project Scheduling	7	14%
14	Contingency Resources	3	6%
15	Software Life Cycle Cost Management	8	16%
16	Staff Training	2	4%

5.1. **The association of critical success factors with respect to the organization type**. In order to answer RQ2, Table 4 shows a list of success factors identified and reported in two types of organizations i.e. research and non-research organizations. Non-research organizations belong to the offshore outsourcing industry, while research organizations are those who are intended to carry out research about offshore outsourcing strategies in order to bridge the gap between academia and industry. We aim to find whether these factors differ from research and non-research organization.

We suggest that understanding the similarities and differences in these factors can positively contribute to the body of portfolio cost management in offshore software development outsourcing relationships. Because of the ordinal nature of data we have used linear by linear association chi-square test in order to investigate the significant differences across the different types of organizations, shown in Table 4. When data is ordinal, in such case, linear by linear association is more powerful than Pearson chi-square test, in order to measure the significant differences [39]. Table 4 depicts that round about four percent of the SLR studies were piloted on research organizations, while twenty-six percent of the original studies were piloted on non-research organizations. This is because our core research area belongs to the offshore software development. The remaining studies i.e. round about 70% literature shows the mixed category. Where mixed category illustrates that these studies neither shows research nor non-research organizations. Comparison of these success factors identified in these two types of organizations indicates that there are more similarities than differences among the success factors. We have found only one significant difference between these two categories i.e. non-research and research organizations, as shown in Table 4.

According to our results, thirteen success factors out of sixteen have been reported in non-research organizations. Amongst these success factors, five factors have been cited ≥30% of the articles. These five factors are 'efficient cost estimation strategies' (80%), 'efficient project management' (70%), 'efficient knowledge sharing management' (42%), 'realistic co-relation between software cost and quality' (30%), and 'efficient efforts estimation' (60%). It is worth noticing that the success factors 'efficient cost estimation strategies', 'efficient project management' and 'efficient software efforts estimation' has the highest percentages i.e. (85%), (62%), and (62%) respectively, for non-research organizations. Our analysis indicate that non-research vendor organizations should focus on 'efficient cost estimation strategies', 'efficient project management' and 'efficient software efforts estimation' to maintain there long lasting successful relations with client organizations in OSDO.

We have found ten success factors for research organizations in the literature. These success factors have been cited in ≥50% of the articles. Three success factors out of these ten factors have the highest percentage (100%) of occurrence for research organizations. These success factors are 'efficient cost estimation strategies', 'efficient software efforts estimation' and 'software life cycle cost management'. Our analyses indicate that the aforementioned motivators have a significant impact on the research organizations. We suggest the research organizations to address these factors to mitigate the gap between offshore software development research and practices.

The purpose of this study is to explore different categories of motivators, which has a positive impact on portfolio cost management in the situation of global software development. However this is still a sign of interrogation that why these success factors are commonly cited in research and non-research organizations. We encourage independent studies on this topic.

Table 4: ANALYSIS OF THE IDENTIFIED SUCCESS FACTORS BASED ON ORGANIZATION's TYPE

S.No	Success Factors for Portfolio Cost Management	Occurrence in SLR N=50	Occurrence in SLR (n=50)						*Chi-square Test (Linear-by-Linear Association)* α = .05		
			Non-research Organization N=13		*Research Organization N=2*		*Mixed* N=35				
			Freq	%	Freq	%	Freq	%	X^2	Df	P
1	Efficient Cost Estimation Strategies	40	11	85	2	100	27	77	.409	1	.522
2	Efficient Project Management	35	8	62	1	50	26	74	.823	1	.364
3	Efficient Knowledge Sharing Management	21	6	46	0	0	15	43	.006	1	.938
4	Efficient Contract Management	4	0	0	0	0	4	11	1.743	1	.187
5	**Realistic Correlation between Cost and Quality of the Software**	15	**7**	**54**	**1**	**50**	**7**	**20**	**5.305**	**1**	**.021**
6	Design and Development Concise Coding	10	4	31	0	0	6	17	.921	1	.337
7	Cost Sourcing	7	3	23	0	0	4	11	.919	1	.338
8	Efficient Resource Allocation and Management	8	2	15	1	50	5	14	.051	1	.821
9	Efficient Software Efforts Estimation	30	8	62	2	100	20	57	.153	1	.695
10	Mechanism for Error Prediction	2	0	0	1	50	1	3	.010	1	.922

11	Planning Realistic Goals	9	1	8	1	50	7	20	.721	1	.396
12	Project Post-mortem Analysis	9	1	8	1	50	7	20	.721	1	.396
13	Project Scheduling	7	0	0	1	50	6	17	1.811	1	.178
14	Contingency Resources	3	1	8	0	0	2	6	.046	1	.829
15	**Software Life Cycle Cost Management**	8	**4**	**31**	**2**	**100**	**2**	**6**	**5.798**	**1**	**.016**
16	Staff Training	2	1	8	0	0	1	3	.516	1	.473

6. Limitations. How valid our findings of critical success factors in PCM in the context of OSDO relationships are? One possible threat to the internal validity is that for any specific paper, their reported success factors may not have been in fact described underlying reason. Internal validity provides support for an overall assessment of the results. We may not be able that this threat is to be controlled independently. The concern authors were not supposed to report the original reasons that why these critical success factors were considered in portfolio cost management in the situation offshore software development outsourcing relationships. The tendency for particular kind of critical success factors reported in various studies may also exist.

During the data extraction process we found several papers lacking sufficient details regarding organization type, in our sample of 50 papers 15 papers have provided details about organization type. Due to such limitations, drawing full fledge picture of the entire 50 articles in the analysis related to the type of organization were impossible. However according to other SLR researchers, this is not a systematic review fault [40]. During studies selection and data extraction process, the Inter-rater reliability test was performed, in order to reduce researcher's bias. However, it was not possible for the secondary reviewer to apply the aforementioned test for each paper.

For the study selection, we have used a number of digital libraries. However, are unable to say that we have used all the numerous digital libraries such as Scopus due to limited resources. The digital libraries we used are more than enough for the generalization of our findings in our study.

7. Conclusion and Future Work. Via SLR, we have identified critical success factors to be addressed by offshore software development outsourcing (OSDO) vendors in order to best manage their portfolio cost management initiatives in the context of OSDO relationships. The results presented in this paper are of core importance to OSDO vendor organizations for successful PCM activities.

In order to answer RQ1 we have identified 16 success factors in total as shown in Table 3. Amongst these factors three were marked as critical based on 50% occurrence criteria. These three critical success factors (CSFs) are 'efficient cost estimation strategies'- 80%, 'efficient project management'-70% and 'efficient software efforts estimation'-60%.

We suggest that vendor organizations should focus on addressing all the 16 identified success factors in general and the 3 critical success factors in particular. We suggest that offshore vendor organizations should focus on these success factors in order to attain valuable outsourcing contracts and maintain long lasting successful relations with client organizations. We have further analyzed and compared these success factors with organization's type based, in order to find out the association of these success factors with different types of organizations. By analyzing the datasets for non-research and research organizations, we have found two significant differences i.e. 'realistic correlation between cost and quality of the software' and 'software life cycle cost management'. We also realize that there are more similarities than differences in these factors based on non-research and research organizations. Our objective is to provide OSDO vendors with a body of knowledge that can help them out in best managing software development costs in a portfolio environment in the situation of offshore software development outsourcing. If vendors are doing outsourcing with different types of organizations, they should focus on the frequently cited success factors identified in Table 4 (RQ2).

As no SLR has previously applied to portfolio cost management in the context of offshore software development outsourcing relationships, so we encourage independent studies on this topic. This will increase confidence levels in our findings and track changes in attitudes to PCM activities over time. We believe that a

good understanding of these factors is vital in improving the offshore vendors for portfolio cost management activities. The findings of our current study, track us for the following goals that we plan to achieve in future:

- Validate the identified success factors of SLR by conducting empirical studies with practitioners and experts working in the offshore software outsourcing industry. The empirical study for validation of our findings will be conducted in the format as done by other researchers [44, 46].
- Analyze the identified success factors based on different variables such as continents, study strategies, organization's size and decades
- Conduct empirical studies to determine the implementation of those success factors, which has frequently cited in our study.

Our ultimate goal is to develop an effective Portfolio Cost Management Model (PCMM) in order to assist outsourcing vendor organizations in the successful management of their portfolio cost management activities. A similar approach has also been used by other researchers [41-46]. This paper contributes to only one component of PCMM i.e. the identification of the success factors via SLR. Our contribution to improving portfolio cost management processes will provide help to other researchers, intended to explore the areas of managing the software development costs in the context of offshore software development relationships.
Many research outputs end up with frameworks and models, which never make it into industrial practices. We expect our work will alleviate this trend in portfolio cost management in the context of offshore software development outsourcing relationships.

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REFERENCES

[1]. Lopez, A., Nicolas, J., & Tov, A. (2009, July). Risks and safeguards for the requirements engineering process in global software development. In *Global Software Engineering, 2009. ICGSE 2009. Fourth IEEE International Conference on* (pp. 394-399). IEEE.

[2]. Deshpande, S., Beecham, S., & Richardson, I. (2013, August). Using the PMBOK Guide to Frame GSD Coordination Strategies. In *Global Software Engineering (ICGSE), 2013 IEEE 8th International Conference on* (pp. 188-196). IEEE..

[3]. Babar, M. A., Verner, J. M., & Nguyen, P. T. (2007). Establishing and maintaining trust in software outsourcing relationships: An empirical investigation. *Journal of Systems and Software*, *80*(9), 1438-1449

[4]. [McLaughlin, L. (2003). An eye on India: Outsourcing debate continues.*Software, IEEE*, *20*(3), 114-117.

[5]. Azzeh, M. (2013, March). Software cost estimation based on use case points for global software development. In *Computer Science and Information Technology (CSIT), 2013 5th International Conference on* (pp. 214-218). IEEE.

[6]. Ji Jiménez, M., Piattini, M., & Vizcaíno, A. (2009). Challenges and improvements in distributed software development: A systematic review.*Advances in Software Engineering*, *2009*, 3.

[7]. Conchúir, E. Ó., Ågerfalk, P. J., Olsson, H. H., & Fitzgerald, B. (2009). Global software development: where are the benefits?. *Communications of the ACM*, *52*(8), 127-131.

[8]. Kumar, S. A., & Thangavelu, A. K. (2013, January). Factors affecting the outcome of Global Software Development projects: An empirical study. In*Computer Communication and Informatics (ICCCI), 2013 International Conference on* (pp. 1-10). IEEE.

[9]. Li, F., Lin, H., Li, S., Guo, C., & Zhao, X. (2012, July). Self-adapting task allocation approach for software outsourcing services. In *Service Operations and Logistics, and Informatics (SOLI), 2012 IEEE International Conference on* (pp. 479-484). IEEE.

[10]. Killen, C. P., Hunt, R. A., & Kleinschmidt, E. J. (2008). Project portfolio management for product innovation. *International Journal of Quality & Reliability Management*, *25*(1), 24-38.

[11]. Platje, A., Seidel, H., & Wadman, S. (1994). Project and portfolio planning cycle: project-based management for the multiproject challenge. *International Journal of Project Management*, *12*(2), 100-106.
[12]. Dye, L. D., & Pennypacker, J. S. (1999). An introduction to project portfolio management. *Project portfolio management, selecting and prioritizing projects for competitive advantage*
[13]. Dekker, G. J., & van den Bosch, F. J. (1983). Functional requirements for the development and use of a software-cost database. *Information & Management*, *6*(4), 225-234
[14]. Li, Y. F., Xie, M., & Goh, T. N. (2008, September). A study of analogy based sampling for interval based cost estimation for software project management. In *Management of Innovation and Technology, 2008. ICMIT 2008. 4th IEEE International Conference on* (pp. 281-286). IEEE.
[15]. Boehm, B. W. (1981). *Software engineering economics* (Vol. 197). Englewood Cliffs (N. J): Prentice-hall.
[16]. Stamelos, I., & Angelis, L. (2001). Managing uncertainty in project portfolio cost estimation. *Information and Software Technology*, *43*(13), 759-768.
[17]. Ozanne, M. R. (2000). Barometer of Global Outsourcing-The Millennium Outlook. *Sponsored by Dun & Bradstreet*
[18]. Magazinius, A., Börjesson, S., & Feldt, R. (2012). Investigating intentional distortions in software cost estimation–An exploratory study. *Journal of Systems and Software*, *85*(8), 1770-1781.
[19]. Shari, L. P. (1998). Software Engineering: Theory and Practice.
[20]. Stamelos, I., Angelis, L., Morisio, M., Sakellaris, E., & Bleris, G. L. (2003). Estimating the development cost of custom software. *Information & Management*, *40*(8), 729-741.
[21]. Attarzadeh, I., & Ow, S. H. (2010, February). A novel soft computing model to increase the accuracy of software development cost estimation. In*Computer and Automation Engineering (ICCAE), 2010 The 2nd International Conference on* (Vol. 3, pp. 603-607). IEEE.
[22]. Reyes, F., Cerpa, N., Candia-Véjar, A., & Bardeen, M. (2011). The optimization of success probability for software projects using genetic algorithms. *Journal of Systems and Software*, *84*(5), 775-785.
[23]. Henry, R. M., McCray, G. E., Purvis, R. L., & Roberts, T. L. (2007). Exploiting organizational knowledge in developing IS project cost and schedule estimates: An empirical study. *Information & Management*, *44*(6), 598-612.
[24]. Costa, H. R., Barros, M. D. O., & Travassos, G. H. (2007). Evaluating software project portfolio risks. *Journal of Systems and Software*, *80*(1), 16-31.
[25]. Akbar, S., Khan, S. U., Alam, A. U., & Alam, S. U. (2012). Portfolio Cost Management in Offshore Software Development Outsourcing Relationships from Vendor's Perspective: a Systematic Literature Review Protocol. *IOSR Journal of Computer Engineering (IOSR-JCE)*, *6*(6), 14-20
[26]. Niazi, M., Mahmood, S., Alshayeb, M., Rehan Riaz, M., Faisal, K., & Cerpa, N. (2013, October). Challenges of project management in Global Software Development: Initial results. In *Science and Information Conference (SAI), 2013* (pp. 202-206). IEEE.
[27]. Azeem, M. I., & Khan, S. U. (2011, December). Intercultural challenges in offshore software development outsourcing relationships: A systematic literature review protocol. In *Software Engineering (MySEC), 2011 5th Malaysian Conference in* (pp. 475-480). IEEE.
[28]. Khan, A. W., & Khan, S. U. (2013). Critical success factors for offshore software outsourcing contract management from vendors' perspective: an exploratory study using a systematic literature review. *Software, IET*, *7*(6), 327-338.
[29]. Khan, S. U., & Azeem, M. I. (2014). Intercultural challenges in offshore software development outsourcing relationships: an exploratory study using a systematic literature review. *Software, IET*, *8*(4), 161-173.
[30]. Auer, M., Trendowicz, A., Graser, B., Haunschmid, E., & Biffl, S. (2006). Optimal project feature weights in analogy-based cost estimation: Improvement and limitations. *Software Engineering, IEEE Transactions on*,*32*(2), 83-92.
[31]. Nan, N., & Harter, D. E. (2009). Impact of budget and schedule pressure on software development cycle time and effort. *Software Engineering, IEEE Transactions on*, *35*(5), 624-637.
[32]. Javed, T. (2007, September). Practicum in software project management: an endeavor to effective and pragmatic software project management education. In *Proceedings of the the 6th joint meeting of the European software engineering conference and the ACM SIGSOFT symposium on The foundations of software engineering* (pp. 471-480). ACM

[33]. Yang, D., Wang, Q., Li, M., Yang, Y., Ye, K., & Du, J. (2008, October). A survey on software cost estimation in the chinese software industry. In*Proceedings of the Second ACM-IEEE international symposium on Empirical software engineering and measurement* (pp. 253-262). ACM.
[34]. Fitzhenry, P., & Gardiner, G. (1995, December). Enhanced software project management by application of metrics and cost estimation techniques. In*Project Management for Software Engineers, IEE Colloquium on* (pp. 4-1). IET.
[35]. Abdel-Hamid, T. K. (1990). Investigating the cost/schedule trade-off in software development. *Software, IEEE*, *7*(1), 97-105.
[36]. Boehm, B. W. (1988). Understanding and controlling software costs. *Journal of Parametrics*, *8*(1), 32-68.
[37]. Peixoto, C. E. L., Audy, J. L. N., & Prikladnicki, R. (2010, August). Effort estimation in global software development projects: Preliminary results from a survey. In *Global Software Engineering (ICGSE), 2010 5th IEEE International Conference on* (pp. 123-127). IEEE.
[38]. Chulani, S., Santhanam, P., Hodges, B., & Anders, K. B. (2007). Metrics-based management of software product portfolios. *Software, IEEE*, *24*(2), 66-72.
[39]. Bland, M. (2015). *An introduction to medical statistics*. OUP Oxford
[40]. Hossain, E., Babar, M. A., & Paik, H. Y. (2009, July). Using scrum in global software development: a systematic literature review. In *Global Software Engineering, 2009. ICGSE 2009. Fourth IEEE International Conference on*(pp. 175-184). Ieee.
[41]. Khan, S. U., Niazi, M., & Ahmad, R. (2011). Barriers in the selection of offshore software development outsourcing vendors: An exploratory study using a systematic literature review. *Information and Software Technology*,*53*(7), 693-706.
[42]. 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. *Journal of systems and software*, *84*(4), 686-699.
[43]. Niazi, M., Wilson, D., & Zowghi, D. (2006). Critical success factors for software process improvement implementation: an empirical study. *Software Process: Improvement and Practice*, *11*(2), 193-211.
[44]. Niazi, M., & Babar, M. A. (2007). De-motivators of software process improvement: An analysis of vietnamese practitioners' views. In *Product-Focused Software Process Improvement* (pp. 118-131). Springer Berlin Heidelberg
[45]. Niazi, M., Ikram, N., Bano, M., Imtiaz, S., & Khan, S. U. (2013). Establishing trust in offshore software outsourcing relationships: an exploratory study using a systematic literature review. *Software, IET*, *7*(5), 283-293.
[46]. Khan, S. U., Niazi, M., & Ahmad, R. (2012). Empirical investigation of success factors for offshore software development outsourcing vendors.*Software, IET*, *6*(1), 1-15.