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Prioritizing the Issues extracted for Getting Right People on Right Project in Software Project Management From Vendors' Perspective

MAJID HUSSAIN¹, HABIB ULLAH KHAN^{ID}2, ABDUL WAHID KHAN^{ID}3, AND SIFFAT ULLAH KHAN^{ID}4

¹Department of Computer Science and Information Technology, Qurtuba University, Dera Ismail Khan 29050, Pakistan

²Department of Accounting and Information Systems, College of Business and Economics, Doha, Qatar

³Department of Computer Science, University of Science and Technology, Bannu 28100, Pakistan

⁴Department of Computer Science and IT, University of Malakand, Chakdara 23050, Pakistan

Corresponding author: Habib Ullah Khan (habib.khan@qu.edu.qa)

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ABSTRACT Software project management inspires and urges the spirit of software developing team members which continues until project completion. Obviously, success of every project based on right selection of team members that ensures to meet the desired requirements of any software developing project. The fundamental aim of current study is to extract and prioritize issues faced by vendors of global software development (GSD) organizations during the selection of right team with having aim to complete the project successfully. As a methodology, a systematic literature review (SLR) used for data extraction and categorization, a questionnaire survey adopted for data validation, and a hierarchical analytical process (AHP) used for prioritizing extracted findings. A total of 12 issues are extracted and grouped into 3 categories (association, teamwork, and fascination). The overall result showed that “association” is the most important category as compare to other categories. Similarly, communication and coordination issues, team’s consistency and stability issues, and lack of expertise issues, etc are highlighted as the most critical issues during selection of right people for the right project from vendors’ perspective.

INDEX TERMS AHP, issues, multi-criteria decision making, right people, SLR, software development project.

I. INTRODUCTION

Outsourcing in software development is famed due to various benefits, for example, cost rescission, easily resource availability, and process enhancement etc [1]. In developed countries, mostly software developing organizations are motivated to shift their developing activities globally [2]. Due to fast development of software project, outsourcing business progressively became a new trend globally [3]. This rapid spreading trend confused the vendor of software developing organization at the time of hiring personnel with having planned to achieve desired goals from software developing project. That’s why, this scenario urged us to extract and prioritize critical issues that faced by

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vendor organization during team selection and also their relevant categories. This research domain is about off-shore software outsourcing. Client-organizations got benefit from off-shore outsourcing because vendors from developing countries usually costing charges are 1/3 less by comparing vendors of onshore companies [4]. Basic purpose of off-shore outsourcing is moving valuable series to a location with lower cost, so, maximum saving should be got from labor resources and cost of their skills [5]. Niazi *et al.* [6] claimed that various companies adopt software development in the global environment to decrease software development costs.

The main focus of research is to highlight that how a vendor organization felt trouble in selecting the right team and how tried to take right decision for hiring team. The success of software developing project depends on several

aspects: the project's team members, budget, and time duration, etc. Lee and Xia [7] claimed that project success is based on staff flexibility (including diversity and autonomy characteristics). Project management is also a main activity that assists to save vendors' organizations from de-tracking in any project scope. Kerzner [8] briefly explained that project management is an organized, planned, controlled, and guided activity for resources of any organization. Experienced and skillful off-shore vendor is necessary to fulfill and satisfy the project needs of any client [9].

The vendor focused on different challenges, for example, assurance of minimum cost (including recruiting cost of team members) from the start of any software developing project. Peeters *et al.* [10] exemplified that cost reduction is the main priority in outsourcing decisions on both the client and vendor end. According to the nature of software development phases, selecting the best personnel is also a major problem for vendors' organizations. Biffi and Halling [11] narrated that the main factor which affected at project performance is team size. A major challenge for vendor is allocating proper roles to team members according to their personalities [12]. According to Smith *et al.* [13] major problem is diversity in skills of personnel. Faultily selection of team by vendors' organization is a key factor that badly affected at overall project performance [14]–[16]. Larger software developing projects necessitate to forming new staff or may have to select new software developing employees [17].

At the time of team selection, finding skillful and qualitative staff members is a very tricky task for the vendor. Bell [18] explained that the team's selection based on their quality should very strong influences on development results and processes as a whole. The main factors that come under the category of reduced project performance are recruiting the projects' team [19], [20]. Cunha *et al.* [21] are asserted that personal traits & cultural distinctiveness of working employees affected the overall process of software development, and "human aspects" are more essential as compare to "technological aspects" [22], [23], [24]. Personal values of software-engineers left deep affection at the final results of any software developing projects [25]. For staffing, the vendor tried to ensure that every employee is professional and meets other necessities because good team is similar to the puzzle in which each slice must have at correct place.

This paper will help to extract and prioritize critical issues that faced by vendor of GSD organization at the time of hiring competent employees for developing a software project. Section-2 of this paper represents a brief literature review to uncover the major issues related to the research topic. Section-3 attributed the methodology which adopted to extract critical issues from existing literature, a questionnaire survey for validation, and a brief description of AHP to prioritize issues. Section-4 consists of overall results and also discussion about our findings. In section-5, threats to validity are highlighted. Implication relating to the study is discussed in section-6. The concluded summary and future-work of our

research study are explained in section-7. We framed some basic questions of our research, which are as follows:

RQ1. What are the issues that should a vendor of an organization must be avoided in getting right people on right project that have negative impact on software project management?

RQ2. How to allocate values to identified issues and how to categorize and prioritize identified critical issues?

II. LITERATURE REVIEW

Niazi *et al.* [6] used SLR and questionnaire survey as a methodology to extract and validate vendors' related critical challenges respectively in the GSD management context. Cavaleri *et al.* [26] presented a complete procedure for the management of problem solving patterns that relates to project. They focused at team members which are directly connected with the performance of project and tried to help the members with patterns for dealing the barriers in knowledge based way. Liu *et al.* [27] briefly explained an alarming question in their paper: Why does the management of projects fail in the IT sector? In the end, the main points discussed that which are the reasons for the collapse in project management? Khan and Keung [28] tried to find critical issues and success factors related to software process improvement in the GSD environment. They used SLR as a methodology to classify and analyze extracted barriers and success factors.

Saleem *et al.* [29] used SLR as a methodology and tried to re-investigate GSD issues. Moreover, categorized them into the company, country, and team level by following the nature of issues. Khan *et al.* [30] pointed out communication and coordination related issues faced by vendor organizations in the GSD context. They adopted SLR and questionnaire survey method for findings and also validation of those findings. Wickramasinghe and Nandula [31] tried to investigate the reasons behind confliction in team relationships and explored divergence in relationships related to team members' performance. They also tried to find out teams' manager support that moderates the concluding relations within members. Jensen *et al.* [32] struggled to find basic causes behind poor software quality, turn-over issues, and lack of collaboration issues with the help of a case-study. At the end, they provided a suggestion to improve deliverable software quality, retention rate, and collaborative environment. Bass *et al.* [33] highlighted turnover problem. They exemplified the factors that may cause of low retention issue within staff of off-shore & on-shore companies. After that, they gave suggestions to mitigate turnover problems and provided implications for improvement in deliverable software quality.

Jain and Suman [34] tried to highlight GSD challenges and stressed that GSD project managers commonly faced communicational barriers, linguistic hurdles, knowledge sharing, and coordination related issues. Abufardeh and Magel [35] showed cultural hurdles & linguistic issues in offshore outsourcing development and emphasized at overall cultural affection on GSD projects. They take a critical review of famous Hofstede's model (developed for cultural aspects) and investigated that how this is useful at the GSD?

Deshpande *et al.* [36] described temporal, geographic, culture related barriers and linguistic problems that mostly occurred globally and thrash out further coordination hurdles between the vendor, team, and client. Eventually, they developed a model to deal with coordination issues of a vendor organization in GSD. Sievi-Korte *et al.* [37] adopted the interview method in the different practitioners of GSD companies and concluded that how various aspects of interaction are inter-linked? And how social factors and structures are affected in software development?

Tjørnehøj *et al.* [38] tried to found well management and team members' related hurdles existed in GSD environment. Their contribution is concerned with providing formal and informal procedures for solving global barriers related to the managerial staff to ensure the project's success. Usman *et al.* [39] analyzed existing literature and retrieved different issues that are badly influenced at quality of software outsourcing. For example, cultural challenges, distance hurdles, communicational barriers, and coordination & cooperation-related issues between team members. Richardson *et al.* [40] focused at major factors that caused trustworthy issues between the working team members. They asserted at the worth of trust in GSD and suggested that collaboration between remotely working team is necessary to develop strong trust. Zahedi *et al.* [41] identified and synthesized knowledge-sharing barriers and their practices. They adopted SLR for data extraction and also applied thematic analysis methodology to analyze findings.

In this research, we tried to present a comprehensive summary of critical issues faced by GSD vendor while selecting the right team. In previous literature, multiple authors tried to highlight GSD team-related issues from vendors' perspectives. By contrast, our unique work is not only to highlight some new issues through reliable research methodology (SLR) and further categorize them on the basis of SLR synthesis but also validated those issues through different experts with the help of empirical study. Moreover, we prioritized identified issues through famous AHP technique that which issue is most critical and how much have higher criticality level from all other issues locally and globally?

III. RESEARCH METHODOLOGY

Our research methodology is attributed at three major steps. In the 1st step, we identified critical types of issues through SLR that vendors faced while selecting the right team. In the 2nd step, a questionnaire survey adopted to validate extracted critical issues, and in the 3rd step issues are further prioritized on their criticality level through AHP. Similarly, categories of issues are also prioritized.

A. SYSTEMATIC LITERATURE REVIEW (SLR)

SLR is a basic source for extracting data from existing literature that exists in different online digital libraries. Akbar *et al.* [42] elaborated that SLR methodology is based on facts adopted to answer particular research questions

from existing literature systematically. SLR considered a major research area in key research methodologies [43]. An advantageous feature of SLR is the reduction of biasness anomalies as compare to traditional result extraction approaches [44]. This is because SLR extracts result purely on the query of search string instead of any favor of the researcher. In the SLR technique, all empirical data types are integrated, which related to a particular study area [45]. We follow same SLR method which adopted by [46]–[48]. There are three major phases of SLR (“planning, conducting, and reporting”) [47]. Okoli and Schabram [49] also guided in detail about the procedure of conducting SLR methodology.

1) FORMATION OF SEARCH STRING

We used different keywords for formulating search string and followed the same procedure which adopted [50], [51]. We framed following search string to find out relevant papers from the existing literature:

((“software outsourcing” OR “offshore software development” OR “software project management” OR “software project” OR “project management”) AND (Vendor OR Seller OR Supplier) AND (Challenges OR Hurdles OR Issues OR Problems OR Barriers) AND (“right people” OR “right personnel” OR “right team” OR “right members” OR “right employees”) AND (“right project” OR “right development”))

2) INCLUSION CRITERIA

We included only those studies which are written in the English language. Studies those help to vendors' organization in getting the right people for developing software project. Included papers which described issues that faced by vendor organization while getting right people. Papers included whose title matched with our research topic match with keywords described in framed search string.

3) EXCLUSION CRITERIA

All those papers are excluded which may not be matched with research questions, which may not related to the vendor or right people, which may not be related to issues faced by vendors' organization while selecting the right team for the right project and all other papers which are duplicated or may not be written in the English language.

4) QUALITY ASSESSMENT OF PUBLICATION

Measuring the quality of the publication, the assessment process initiated at the same time as when the data extraction process initiated. Quality of publication is completely based on the questions, which are as follows:

- I. Does the extracted studies are published in a standard publication?
- II. Does the issue(s) founded in the paper faced by GSD vendor during the selection of the right team?

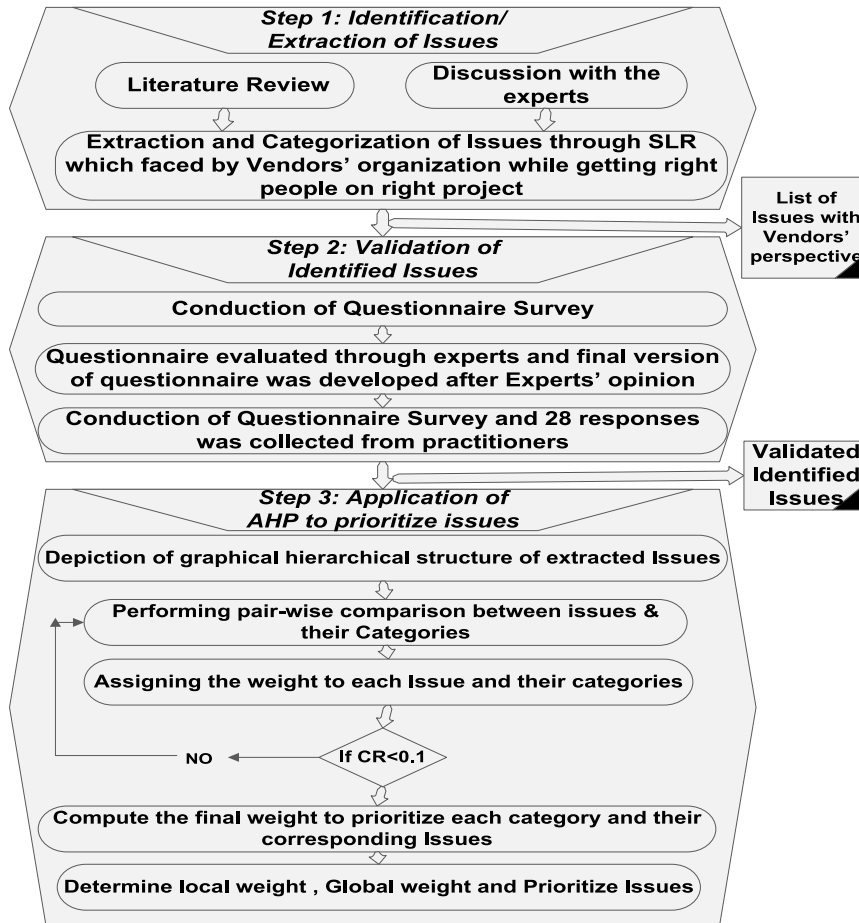


FIGURE 1. Proposed research methodology.

III. Does the selected papers are written in the English language?

5) SOURCES OF SEARCH

Main sources of our study are digital libraries on which search string is applied for getting relevant results, depicted in Table 1.

6) SELECTION OF PRIMARY STUDY

Selection of primary sources is performed by reviewing keywords, titles, and abstracts of papers. Major aim of this type of finding is to exclude results that are not related to our research problem and check the include/exclude conditions with the help of a complete review of different papers. The final selection of papers from different databases depicted in Table 1.

IV. RESULTS

A. SLR FINDINGS

To answer RQ1, we extracted 12 critical types of issues from 44 final selected research papers and also categorized all issues into three different types of categories (association, teamwork, and fascination) based on the SLR synthesizing.

TABLE 1. List of sources of search with selected articles.

Digital Library	Total Results	Primary Selection	Final Selection
IEEE Xplorer	19921	112	26
Science Direct	97	6	2
ACM	145	8	0
Google Scholar	294	13	6
SpringerLink	708	14	6
Emerald Insight	1936	7	4
Overall results	23101	160	44

Further detail of every issue is as follows and depicted in Table 2.

CH12 (Geographic Boundaries issues) frequency is 30/44, and the percentage ratio is almost 70%. In GSD, different critical risky factors, for example, cultural barriers, and temporal issues take place as challenging issues due to the geographic distributive environment [52], [53]. CH1 (Communication and Coordination issues) frequency is 29/44 and has 66% percentile ratio. Communicational issues have basic distress in distributed environments and direct badly affected at project success [54]. CH2 (Lack of Expertise issues) frequency is 24/44 and has an almost 54% percentile ratio. Identifying and selecting expert employees in the GSD environment is comes under the main areas of issues [55]. CH3 (Shortage of Trained

TABLE 2. List of critical issues having frequency and percentage with their relevant category.

Category	Name of Issues	Frequency	Percentage
Association	Communication And Coordination Issues(CH1)	29	66%
	Lack of Expertise issues(CH2)	24	54%
	Shortage of Trained and Experienced employees issues(CH3)	22	50%
	Lack of Eminence Education & Domain Knowledge issues(CH4)	12	27%
	Lack of Conviction issues(CH5)	11	25%
Teamwork	Lack of Team Management issues(CH6)	21	48%
	Team’s Consistency and Stability issues(CH7)	15	34%
	Team’s collaboration & Cooperation issues(CH8)	13	30%
Fascination	Lack attractive packages issues(CH9)	19	43%
	Poor recruitment system issues(CH10)	12	27%
	Lack of employee’s Respect issues (CH11)	12	27%
	Geographic Boundaries issues(CH12)	31	70%

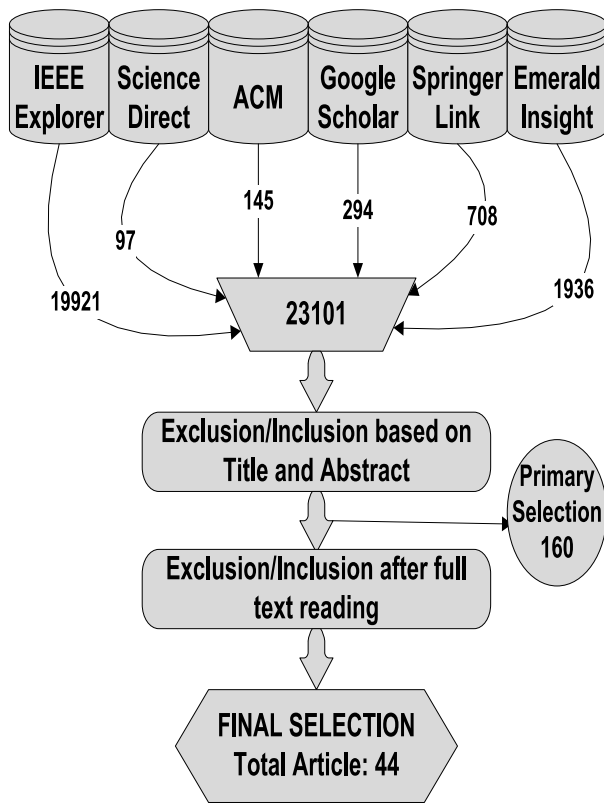


FIGURE 2. Approach for article selection.

and Experienced employees issues) frequency is 22 over 44, which shows the percentage ratio is 50%. Software projects engage most harshness, especially in the GSD team, which must need skillful employees [56].

CH6 (Lack of Team Management issues) frequency is 21/44 and has a 48% percentile ratio. Overall 80% vendors working in the GSD firms’ environment faced main issues due to the poor management and insufficient preparation [57]. CH9 (Lack of attractive packages issues) frequency is 19 over 44, which shows a percentage ratio of almost 43%. Puli-paka [58] expressed from vendors’ perspective that the cost

of employees’ unexpected salary packages is also the main reason for contract termination with the client. CH7 (Team’s Consistency and Stability issues) frequency is 15/44 and 34% percentile. García-Crespo et al. [59] claimed that team stability related issues are also a headache for the manager of any GSD organization. The overall frequency of CH8 (Team’s collaboration & Cooperation issues) is 13/44 which represented percentage ratio nearly 30%. Socio human sources issues affected at overall project results and performance [60].

CH4 (Lack of Eminence Education & Domain Knowledge issues) frequency is 12/44 and has a 27% percentile ratio. Project absolute ended within a limited period required a diversity of knowledge & skills [61]. CH10 (Poor recruitment system issues) frequency is 12/44 and has a 27% percentile ratio. Grossman [62] claimed as a drawback that most human resource management managers spend almost 80% time at the recruitment process. CH11 (Lack of employee’s Respect issues) frequency is 12/44 and has a 27% percentile ratio. Different types of reasons between staff, for example, disliking, dissatisfaction, and annoyance etc become the main reason for disrespect [63]. CH5 (Lack of Conviction issues) frequency is 11/44 and has a 25% percentile ratio. Piri et al. [64] also highlighted that distrust at employees in the GSD environment is come under the category of serious issues.

B. QUESTIONNAIRE DEVELOPMENT

A questionnaire is a fundamental tool for gathering information from public knowledge and gets awareness from natural challenges. Aarnio [65] said that a questionnaire survey is a diary survey in which questions are asked from participants individually. We send questionnaires using email to 40 people who are currently working in different software houses of globe but only 28 people filled questionnaire. The questionnaire survey task is accomplished in forty days (15th DEC 2019 to 23th JAN 2020).

In the developed questionnaire, we enlisted a total of 12 issues and against every issue, put five options (“Strongly Agree”, “Agree”, “Neutral”, “Disagree”, and

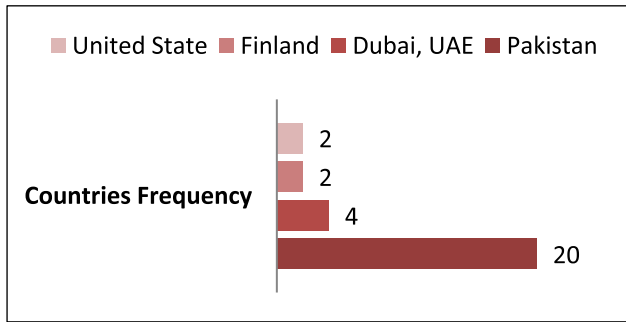


FIGURE 3. Country affiliations of survey practitioners.

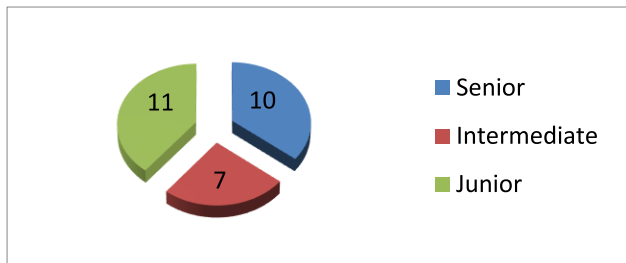


FIGURE 4. Work experience of survey practitioners.

“Strongly Disagree”) for getting feedback. Khan *et al.* [66] urged that modern researchers believe in adding the “Neutral” option is significant because reacting of neutral regarding any type of topic or statement is considered acceptable reaction.

1) PILOT TESTING OF DEVELOPED QUESTIONNAIRE

The pretesting process performed with 3 organizational managers working in different software houses to ensure the developed questionnaire’s reliability and consistency. When doing request to get feedback about the experts’ questionnaire, we guaranteed to all practitioners that collected data will always be secured. It will not be leaked and not be shared with any third party at any cost. All experts are delighted with our framed questionnaire survey form with a minor changes. The ultimate version of our developed questionnaire finalized after doing minor types of changes based on reviewed valuable feedback of experts (e.g. editing information of respondents in general section). Sample of our questionnaire survey is presented as Appendix A.

2) DATA SOURCING OF QUESTIONNAIRE

As 28 practitioners take participate in our survey and provide their precious responses. After getting feedbacks, we reviewed all responses manually one by one and found that all of the practitioners fully responded to our asked questions. The demographic of practitioners is also given in Appendix B. Further detail of practitioners is as follows:

3) VALIDATION OF IDENTIFIED CRITICAL ISSUES

To exemplify the feedbacks of respondents, Table 3 is created, in which first column generally consists of serial no, 2nd column contained the name of issues whereas 3rd column is attributed at positive, negative, and neutral option. We put

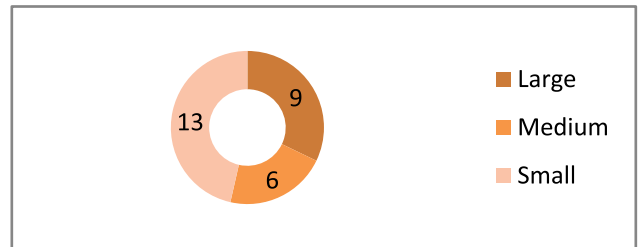


FIGURE 5. Organizational sizes of practitioners.

“strongly agree (SA)” and “agree (A)” in one category and named that category as “positive”. We put “strongly disagree (SD)” and “disagree (D)” in the second category and named that category as “negative” whereas the third category named as “neutral (N)”. In Table 3, “negative category” signified the percentage of practitioners’ responses that how many experts disagree with identified critical issues? “Positive category” enriched with agree responses, and “neutral category” demonstrates neutral feelings regarding identified critical issues.

From the summary of Table 3, most practitioners agree with identified critical issues because almost all issues have more than 70 percent positive responses. Here can be decided that further analysis should be initiated at identified issues.

C. ANALYTIC HIERARCHY PROCESS (AHP)

Multi criteria decision making (MCDM) techniques are helpful for vendors of software developing organization in taking right decision from various available choices and also supportive in prioritizing different management related hurdles as well. Basically, AHP is a tool of MCDM theory which provides valuable analysis and consequences, especially in software project management concept. The AHP technique is used for decision-making and decides relevant importance between multiple criteria [67]. AHP used to identify and prioritize issues and their concerned categories [68]. Zarbakhshnia *et al.* [69] exemplified that AHP used for pair wise comparison method to calculate weights of the criteria within decision-making issues. First of all, Saaty [70] gave the AHP concept from its fundamental level. AHP adopted by many researchers, for example, Shameem *et al.* [71] tried to extract and prioritize different issues for scaling agile solutions in a GSD environment. Within the GSD environment, Akbar *et al.* [68] tried to expand the classification and prioritization of critical issues related to the requirement change management (RCM) process. Kabra *et al.* [72] used AHP to identify and prioritize coordination-related hurdles in managing humanitarian supply chains. We used AHP to prioritize the identified issues based on their criticality level and prioritize their respective categories. AHP methodology involves the following 3 fundamental phases.

- I. Decomposing the complicated decision-making issue into basic hierarchy format.
- II. Concluding the priority-weight of issues and their subordinate issues via pair-wise comparisons.
- III. Verifying the consistency level of findings.

TABLE 3. List of challenges with corresponding responses through questionnaire survey.

S. No	Challenge Name	Total Responses (N=28)							
		Positive			Negative			Neutral	
		SA	A	%	SD	D	%	N	%
CH1	Communication and Co-ordination issues	4	16	71.43	7	0	25.00	1	3.57
CH2	Lack of expertise Issues	3	18	75.00	5	1	21.43	1	3.57
CH3	Shortage of trained and experienced employees issues	4	17	75.00	2	2	14.29	3	10.71
CH4	Lack of Eminence Education & Domain Knowledge issues	1	19	71.43	2	2	14.29	4	14.29
CH5	Lack of conviction issues	0	21	75.00	5	0	17.86	2	7.14
CH6	Lack of Team Management issues	6	16	78.57	2	2	14.29	2	7.14
CH7	Team's Consistency and Stability issues	4	20	85.71	3	0	10.71	1	3.57
CH8	Team's collaboration & Cooperation issues	6	17	82.14	1	1	7.14	3	10.71
CH9	Lack of attractive packages issues	2	18	71.43	3	0	10.71	5	17.86
CH10	Poor recruitment system issues	10	13	82.14	1	1	7.14	3	10.71
CH11	Lack of employee's Respect issues	3	20	82.14	2	1	10.71	2	7.14
CH12	Geographic boundaries Issues	3	19	78.57	4	2	21.43	0	0.00

TABLE 4. Importance detail of standard 9 point scale.

Specification	Equally important	Moderately Important	Strongly Important	Very Strongly Important	Extremely Important	Intermediate Values
Values	1	3	5	7	9	2, 4, 6, 8

1) DECOMPOSING THE COMPLICATED DECISION MAKING ISSUE INTO BASIC HIERARCHY FORMAT

In the 1st phase of AHP, complicated decision-making issue is further arranged into the organized hierarchical format. According to the standard rules of AHP, It is necessary that the organized structure of the issue at least must have 3 levels, as depicted in Figure 6. In phase-1, we shaped an organized hierarchical structural format. In 2nd phase, we presented issues, whereas phase-3 attributed at subordinate issues.

2) CONCLUDING PRIORITY WEIGHT OF ISSUES AND THEIR SUBORDINATE ISSUES THROUGH PAIR-WISE COMPARISONS

In the 2nd phase, the process of calculating priority-weight is done through pair-wise comparison of a table. At every phase, issues are pair-wise compared to their manipulation stage and based on particular criteria at the top phase. In the AHP method, we adopted the standard 9 point scale comparison concept of Wind and Saaty [73] to perform a pair-wise comparison between issues to conclude the significance of one issue to another issue. This 9-point comparison scale concept (depicted in Table 4) is also adopted by [74]–[77]. As a whole, the table of pair-wise comparison is done for every issue and their subordinate issues respectively.

For example, $C = \{C_j/j=1, 2, \dots, n\}$, from which “n” is evaluating issue and each element of evaluating table A, i.e. a_{ij} (i,j=1, 2, 3, ..., n).

Synthesized relative-weight is explained as Equation 1:

$$A = \begin{bmatrix} 1 & a_{12} & \dots & a_{1n} \\ a_{21} & 1 & \dots & a_{2n} \\ \dots & \dots & \dots & \dots \\ a_{n1} & a_{n2} & \dots & 1 \end{bmatrix} \text{ where } a_{ij} = 1/a_{ji}, a_{ij} > 0.1 \quad (1)$$

“A” is a pair-wise comparison table for issues; $\lambda \max$ is used for largest Eigen-value and “W” used for weight-vector to resolve the characteristics of the equation shown in

Equation 2.

$$AW = \lambda \max W \quad (2)$$

3) VERIFYING CONSISTENCY LEVEL OF FINDINGS

In AHP, a pair-wise comparison table must have consistency. To conclude consistency, consistency-index (CI) and consistency-ratio (CR) are used for assistance as shown in Equation 3 and Equation 4 respectively.

$$CI = \frac{\lambda \max - n}{n - 1} \quad (3)$$

$$CR = \frac{CI}{RI} \quad (4)$$

From which, $\lambda \max$ is used for the largest Eigen-value of table-A, and “n” indicates orders of the issues. RI is a consistency value of the random index that contains different values based on the total number of issues, as listed in Table 5. The overall accepted value of consistency ratio (CR) is 0.10. If the overall value of $CR < 0.10$, it means the priority weight of the issue is satisfactory & acceptable and then we can also summarized that Table-A have adequate consistency. If the overall value of $CR > 0.10$, then it is necessary to reiterate the evaluating procedure from Phase-1 to improve consistency.

4) APPLICATION OF AHP FOR PRIORITIZING ISSUES

Previous chapters recognized the critical issues and also assured validation of issues. Now from this section, we adopted AHP methodology to prioritize the issues. Further brief explanation of steps which are used in AHP to prioritize issues is showed in Figure 7.

a: IDENTIFYING GOAL, CATEGORIES (ISSUES) AND SUBORDINATE ISSUES

In the 1st step of AHP, We identified the fundamental goal, factors of that goal, and their relevant subordinate issues (depicted in Table 2) for taking further necessary action.

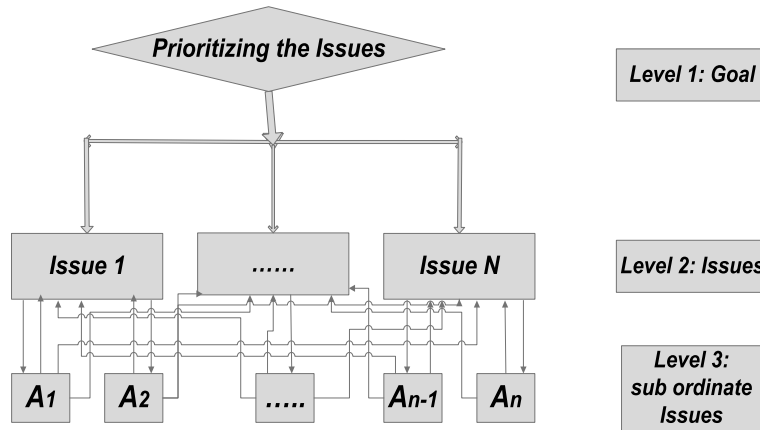


FIGURE 6. Hierarchical structure of AHP.

TABLE 5. Relation between CI and table size.

Table Size	1	2	3	4	5	6	7	8	9	10
Consistency Index	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

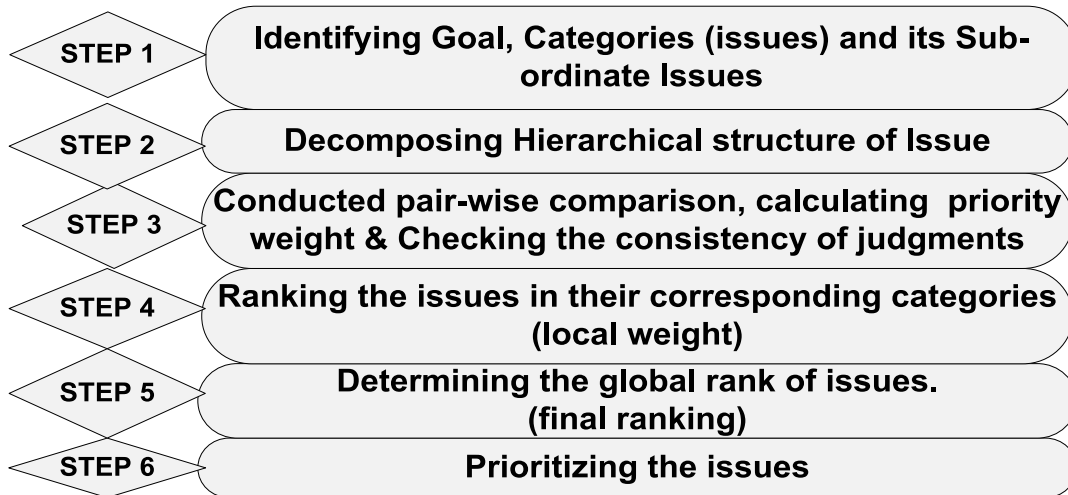


FIGURE 7. Steps involved in AHP.

b: DECOMPOSING HIERARCHICAL STRUCTURE OF ISSUE

In the 2nd step, we arranged the issues in a hierarchical structure as depicted in Figure 8. We planned to put our major aim of study on top-level hierarchy, whereas its categories and concerned issues are depicted at level 2 and level 3 respectively. The demographic shape of our fundamental goal, its synthesized categories, and their concerned critical issues are depicted in Figure 9.

c: CONDUCTING PAIR WISE COMPARISON, CALCULATING PRIORITY WEIGHT AND CHECKING CONSISTENCY OF FINDING

In the 3rd step, we conducted a pair-wise comparison of 3 main categories of our research findings and their concerned issues. Through scale values (Table 4), matrices of pair-wise comparison are prepared for association category, teamwork category, and for fascination category (which are shown in Tables 6, 8, and 10, respectively).

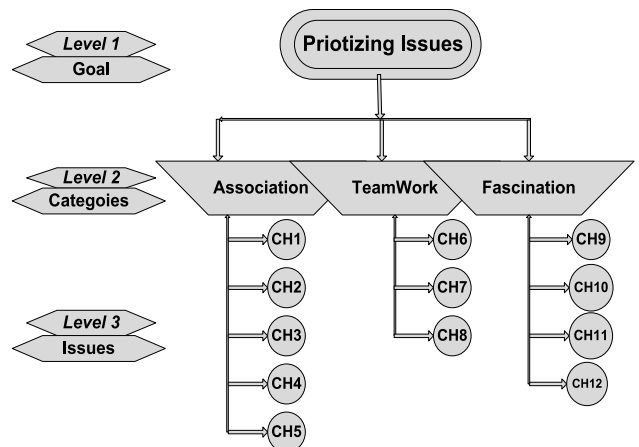


FIGURE 8. Hierarchical structure of study for AHP.

Similarly, we made pair-wise comparisons between the issues of concerned categories depicted in Table 12. For

TABLE 6. Pair wise comparison between issues of "Association" category.

S. No	CH1	CH2	CH3	CH4	CH5
CH1	1.00	2.00	8.00	8.00	8.00
CH2	0.50	1.00	5.00	4.00	2.00
CH3	0.13	0.20	1.00	0.33	0.20
CH4	0.13	0.25	3.00	1.00	0.33
CH5	0.13	0.50	5.00	3.00	1.00

TABLE 7. Normalized table of "Association" category.

S. No	CH1	CH2	CH3	CH4	CH5	Priority Weight
CH1	0.53	0.51	0.36	0.49	0.69	0.517
CH2	0.27	0.25	0.23	0.24	0.17	0.233
CH3	0.07	0.05	0.05	0.02	0.02	0.040
CH4	0.07	0.06	0.14	0.06	0.03	0.071
CH5	0.07	0.13	0.23	0.18	0.09	0.138
						Σ=1.00

λmax= 5.313; CI=0.078; RI=1.12; CR=0.07<0.1

TABLE 8. Pair wise comparison between issues of "Teamwork" category.

Sr. No	CH6	CH7	CH8
CH6	1.00	0.20	2.00
CH7	5.00	1.00	6.00
CH8	0.50	0.17	1.00

TABLE 9. Normalized table of "Teamwork" category.

Sr. No	CH6	CH7	CH8	Priority Weight
CH6	0.15	0.15	0.22	0.174
CH7	0.77	0.73	0.67	0.723
CH8	0.08	0.12	0.11	0.103
				Σ=1.00

λmax= 3.029; CI=0.015; RI=0.58; CR=0.03<0.1

pair-wise comparison, we normalized the table of pair-wise comparison by dividing each element of a table over the sum of its column. Next, we collected the priority weight of every subordinate issue through average across the row. For elaboration, the priority-weight of issues within 'association category' is showed in Table 7. In Table 7, overall summation of all priority weight is calculated as 1. Next, priority weight depicts the related weight-age of subordinate issues (categorized in the association category).

Within the association category, CH1 (Communication and Coordination issues) found the most important critical issue as compared to CH1 (Communication and Coordination issues) founded the most important critical issue compared to CH2, CH3, CH4, and CH5.

Few short terms used at the end of tables, in which CI means consistency index, CR means consistency ratio, and RI means random consistency index.

From Table 7, we computed the CI this way:

$$CI = \frac{\lambda_{max} - n}{n - 1} = \frac{5.313 - 5}{5 - 1} = \frac{0.313}{4} = 0.078$$

From the above result of CI, "n" means total number of issues that will be compared. We opted a proper value of RI=1.12 from Table 5 because of n=5. In the final step,

TABLE 10. Pair wise comparison between issues of "Fascination" category.

Sr. No	CH9	CH10	CH11	CH12
CH9	1.00	2.00	4.00	6.00
CH10	0.50	1.00	2.00	4.00
CH11	0.25	0.50	1.00	4.00
CH12	0.17	0.25	0.25	1.00

TABLE 11. Normalized table of "Fascination" category.

S. No	CH9	CH10	CH11	CH12	Priority weight
CH9	0.52	0.53	0.55	0.40	0.502
CH10	0.26	0.27	0.28	0.27	0.268
CH11	0.13	0.13	0.14	0.27	0.167
CH12	0.09	0.07	0.03	0.07	0.064
					Σ=1.00

λmax= 4.099; CI= 0.033; RI= 0.9; CR=0.04 <0.1

TABLE 12. Pair-wise comparison between "Categories of Issues".

Categories	Association	Teamwork	Fascination
Association	1.00	4.00	8.00
Teamwork	0.25	1.00	4.00
Fascination	0.13	0.25	1.00

we computed the CR this way:

$$CR = \frac{CI}{RI} = \frac{0.078}{1.12} = 0.07$$

As CR is less than 0.1, so, we can state that priority-weights of issues are acceptable. We found the priority-weight of all issues for teamwork and fascination by following the same procedure in Table 9 and Table 11, respectively. Furthermore, with the same procedure, priority weight between the "categories of issues" is computed (shown in Table 13).

d: RANKING THE ISSUES AND THEIR CONCERNED CATEGORIES (LOCAL WEIGHT)

Based on priority-weight results (shown in column 4 of Table 14), Ranking of the critical issues with their specific category also computed and then enlisted in column 5 of Table 14.

e: DETERMINING THE GLOBAL RANK OF ISSUE

In AHP, global weight represents the participation of a particular issue inside the inclusive study. Within hierarchical structure, product of the local weight of an issue and weight of its concerned category considered as global weight of that issue e.g., global weight of issue CH1 is 0.517*0.702=0.3629. We provided global weight of every issue of in the column 6 of Table 14.

f: PRIORITIZING THE ISSUES

In the last step, final rank of every issue is evaluated based on global weights. Table 15 concluded the overall findings in summarized form. The Issue "CH1: Communication and

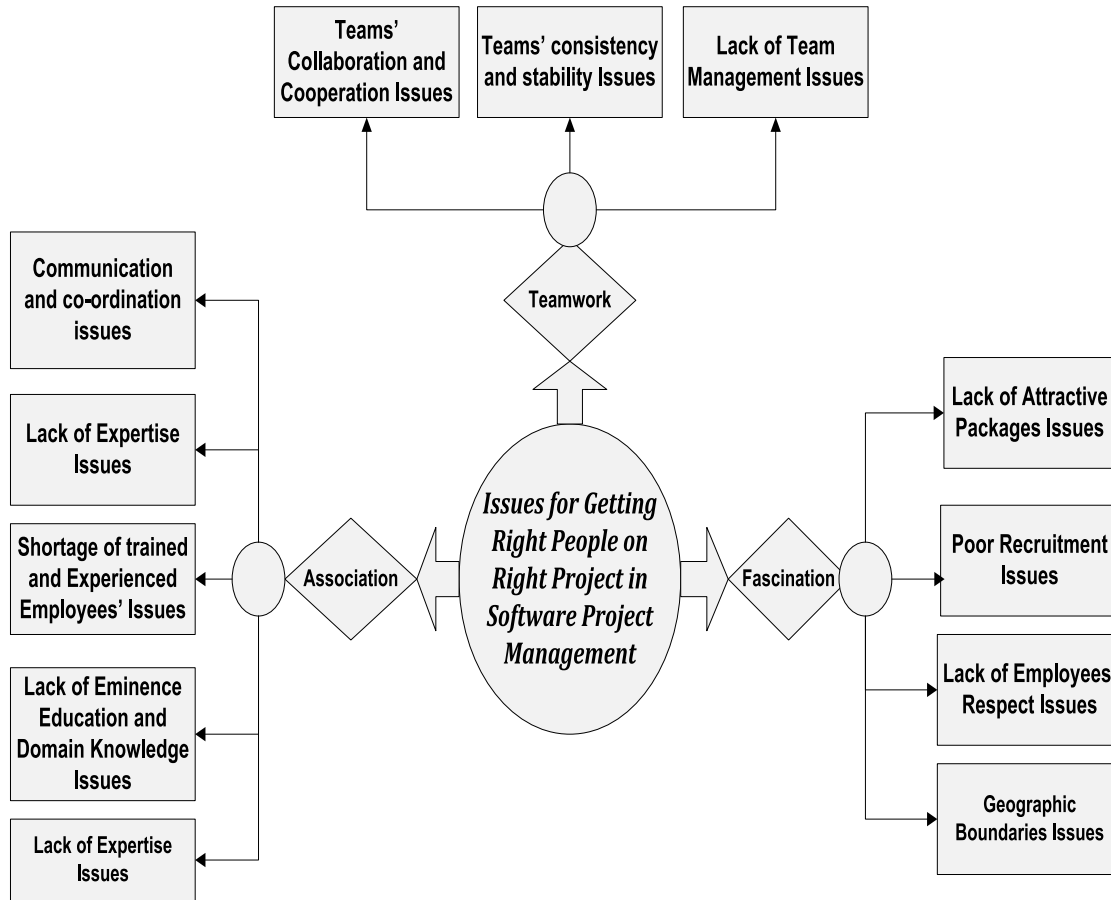


FIGURE 9. Categorization of issues.

TABLE 13. Normalized table for categories of issues.

Categories	Association	Team-work	Fascination	Priority Weight
Association	0.73	0.76	0.62	0.702
Teamwork	0.18	0.19	0.31	0.227
Fascination	0.09	0.05	0.08	0.072
				$\Sigma=1.00$

$\lambda_{max}= 3.054$; $CI= 0.027$; $RI=0.58$; $CR=0.05<0.1$

Coordination issues” is founded as the most significant or critical issue among all twelve identified issues and whereas “CH12: Geographical boundaries issues” is founded as the least significant or critical issue among all twelve identified issues. Further detail of every critical issue with their priority weights given in Table 15:

g: AHP RESULT

On the results of the categories in Table 14, a local ranking of issues is as follows:

Within the Association category, “Communication and Coordination issues” have the highest criticality level from

all of its related issues, “Lack of expertise Issues” takes second place on a critical basis, third place of criticality level has “Lack of conviction issues”, fourth place of criticality level has “Lack of Eminence Education & Domain Knowledge issues”, and whereas “Shortage of trained and experienced employees issues” has fifth number. Within the Teamwork category, “Team’s Consistency and Stability issues” has the highest criticality level as compared to other its relevant issues, second is “Lack of Team Management issues”, and finally “Team’s collaboration & Cooperation issues” is at last place. Within Fascination category on the comparison of local ranking, “Lack of attractive packages issues”, “Poor recruitment system issues”, “Lack of employee’s Respect issues”, and “Geographic boundaries Issues” have 1st, 2nd, 3rd, and 4th place respectively.

In Table 15, based on AHP conclusion, CH1 (communication and coordination issue) founded most critical issue as compared to all 12 issues, CH7 (Team’s Consistency and Stability issues) is the second most critical type of issue. CH2 (lack of expertise issues) founded the third most critical issue that becomes extra pain for GSD vendors at the time of the right staff hiring procedure. CH5 (Lack of conviction issues) nominated fourth most critical issue. CH4 (Lack of

TABLE 14. Summary of local and global weights issues and their rankings.

Category	Weight of category	Issues	Local Weight	Local Rank	Global Weight	Global Rank
Association	0.70	CH1	0.517	1	0.3629	1
		CH2	0.233	2	0.1636	3
		CH3	0.040	5	0.0281	8
		CH4	0.071	4	0.0498	5
		CH5	0.138	3	0.0969	4
Teamwork	0.23	CH6	0.174	2	0.0395	6
		CH7	0.723	1	0.1641	2
		CH8	0.103	3	0.0234	9
Fascination	0.07	CH9	0.502	1	0.0361	7
		CH10	0.268	2	0.0193	10
		CH11	0.167	3	0.0120	11
		CH12	0.064	4	0.0046	12

TABLE 15. Prioritizing the issues.

S. No	Name of Issues	Priority
CH1	Communication and Coordination issues	1
CH7	Team's Consistency and Stability issues	2
CH2	Lack of expertise Issues	3
CH5	Lack of conviction issues	4
CH4	Lack of Eminence Education & Domain Knowledge issues	5
CH6	Lack of Team Management issues	6
CH9	Lack of attractive packages issues	7
CH3	Shortage of trained and experienced employees issues	8
CH8	Team's collaboration & Cooperation issues	9
CH10	Poor recruitment system issues	10
CH11	Lack of employee's Respect issues	11
CH12	Geographic boundaries Issues	12

Eminence Education & Domain Knowledge issues) founded fifth most critical issue. CH6 (Lack of Team Management issues) is prioritized as the sixth most critical issue. CH9 (Lack of attractive packages issues) is nominated as the seventh most critical issue with vendors' perspective while selecting the right team. CH3 (Lack Shortage of trained and experienced employees issues), CH8 (Team's collaboration & Cooperation issues), CH10 (Poor recruitment system issues), CH11 (Lack Lack of employee's Respect issues), and CH12 (Geographic boundaries Issues) are founded as eighth, ninth, tenth, eleventh, and twelfth most critical issues respectively.

V. THREATS TO VALIDITY

- I. It is possible that few authors (included in research) may not provide authentic, exact reasons behind issues with vendors' perspectives raised at the time of right team selection.
- II. It is possible that practitioners may not provide their actual opinions during filling up questionnaire survey due to lack of concentration (as they always remain busy in their job work).

- III. We applied SLR on limited papers for extracting issues relating to our research question. Our overall findings are based on the belief of authors, which belongs to our final selected research papers.
- IV. Some of our final selected research papers published before 15 to 20 years.
- V. Prioritizing procedure of issues through AHP entirely based on discussion and subjective approach and also based on experts' opinions. It is a possibility that this fast type of approach may mess-up the effectiveness and efficiency of the study. Anyhow, CR calculated for every pair-wise comparison table represents acceptable and adequate internal validation in prioritizing issues.

VI. IMPLICATION OF STUDY

- I. Our research work has implications for both practitioners and researchers as its results provide knowledge to both practitioners and researchers in the GSD environment regarding software development projects.
- II. All identified critical issues with vendors' perspectives are a significant contribution to the academic world. This may help researchers to understand areas or issues, that is, researchers got help from this paper for extracting new more issues in the GSD environment.
- III. AHP method is used for group decision making issues. This research may help the researchers to imitate the AHP method in their research work for evaluating the ranking of issues based on their importance.
- IV. Priority weights and ranks of issues in AHP are also important for researchers regarding decision-making points of view. For example, helpful in conduction of case studies to assist organizations in evaluating and revising their approaches related to a method for the extraction of critical issues which faced by vendors' organization.

VII. CONCLUSION AND FUTURE WORK

Software outsourcing is a top trend in the modern world because it has various advantages but vendors of GSD organi-

zation faced many critical challenges during team selection. In this research, we got overall 12 team selection related issues with vendors’ perspectives which are extracted from existing literature using SLR, and then issues are further categorized into three categories: association, teamwork, and fascination. The identified issues validation is done through the analysis of 28 questionnaire responses. At the final stage, ranking of issues is evaluated through AHP methodology. The conclusion of this research represents that association category is most significant category; whereas Communication and Coordination issues, Team’s Consistency and Stability issues, Lack of expertise Issues, Lack of conviction issues, and Lack of Eminence Education & Domain Knowledge issues are the most important and critical type of issues from

all 12 identified issues with vendors’ organization perspective at the time of right team selection.

In the future, our research aims to develop a model that may help GSD companies for assessing their mitigation level against identified critical challenges. Furthermore, in the future, our research results will be used to develop a model that may assist the vendor of an organization while selecting appropriate software developing team. This research is also a way for researchers to conduct another SLR to find out new issues and extract their best practices for mitigating those issues that are discussed early in this research study.

APPENDIX A: QUESTIONNAIRE SURVEY FORM

SECTION 1: PARTICIPANT GENERAL INFORMATION				
Please write your full name.				
Please specify your job title.				
Specify your work experience in years.				
Write the name of your organization please.				
Write the address of your organization.				
Please write your email address.				
Write your cell No. (Optional)				
Have you ever been participated in an outsourcing/off shoring Global Software Development (GSD) project in your company? If yes then please specify.				
What is your role in organization?				
SECTION 2: ORGANIZATIONAL INFORMATION				
Please specify company country location.				
What is the primary business of your company?	Outsourcing	In-house Development	Other	
What is the type of your company?	Multinational	National	Don't Know	Other
Approximately how many staff members are employ in your company?	Less than <20	b/w 20 and 200	Greater than >200	
What type of systems is your company concerned with?	Safety critical	Business Systems	Telecommunications	Data processing
	Real time systems	Window based	Embedded systems	Web development
	Mobile Apps	API development	Cloud Computing	If Other, please specify
Is your company relies on industry standards in order to select offshore vendor (e.g. CMMI)?	Yes	No	Don't Know	
SECTION 3: QUESTIONS RELATED TO RESREACH WORK				

This section contains critical issues which are faced by vendors’ organization at the time of hiring software developing team. Please tick (✓) appropriate box based on your experience. {SA: Strongly Agree; A: Agree; N: Neutral; D: Disagree; SD: Strongly Disagree}

Challenge Name	SA	A	N	D	SD
Geographic boundaries Issues					
Communication and Coordination issues					
Lack of expertise Issues					
Shortage of trained and experienced employees issues					
Lack of Team Management issues					
Lack of attractive packages issues					
Team’s Consistency and Stability issues					
Team’s collaboration & Cooperation issues					
Lack of Eminence Education & Domain Knowledge issues					
Poor recruitment system issues					
Lack of employee’s Respect issues					
Lack of conviction issues					

APPENDIX B: DEMOGRAPHIC OF PRACTITIONERS

Sr. No	Job Title	Experience in years	Company Country	Primary Business of Company	Total company staff members?	Level of CMMI
1	Senior Net Developer	10	Pakistan	Outsourcing	>200	N/A
2	Software Developer	4	Finland	In-House Development	>200	Don't know
3	Web Developer	2	Pakistan	Outsourcing	<20	4
4	Quality Assurance Manager	3	Pakistan	In-House Development	<20	3
5	Full Stack Engineer	9	Dubai, UAE	In-House Development	>200	1
6	Principal Solution Architect	11	Pakistan	Outsourcing	between 20 to 200	N/A
7	SEO	5	Pakistan	In-House Development	<20	4
8	Free Lancer	5	Pakistan	In-House Development	<20	2
9	Senior Data Developer	2	Dubai, UAE	In-House Development	>200	5
10	Software Quality Assurance Engineer	2	Dubai, UAE	In-House Development	>200	5
11	Web Developer	16	Finland	In-House Development	<20	N/A
12	Software Engineer	1.5	Pakistan	Outsourcing	<20	Don't know
13	Software Engineer	3.5	Pakistan	Outsourcing	<20	Don't know
14	Software Engineer	1.5	Pakistan	Outsourcing	<20	Don't know
15	Software Engineer	2	United State	Outsourcing	>200	5
16	Senior Software Engineer	2	Pakistan	Outsourcing	<20	Don't know
17	Developer	2	Pakistan	In-House Development	<20	Don't know
18	React Native Developer	5	Pakistan	Outsourcing	>200	3
19	Developer	3	Pakistan	In-House Development	<20	N/A
20	Senior Digital Marketer	2	Pakistan	In-House Development	between 20 to 200	4
21	SEO Internee	1	Pakistan	In-House Development	between 20 to 200	4
22	SEO Expert	2	Pakistan	USA Based project Handle	between 20 to 200	4
23	Developer	3	Pakistan	In-House Development	between 20 to 200	4
24	Manager	5	Pakistan	In-House Development	between 20 to 200	5
25	Senior Software Developer	8	Pakistan	In-House Development	<20	N/A
26	Developer	4	Pakistan	Outsourcing	<20	Don't know
27	Developer	4	United State	Outsourcing	>200	5
28	Senior Developer	5	Dubai, UAE	In-House Development	>200	5

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MAJID HUSSAIN received the master's degree in information technology from the Department of Computer Science and Information Technology, University of Sargodha, Pakistan. He is currently pursuing the M.S. degree in computer science with the Qurtuba University of Science and Information Technology, Dera Ismail Khan, Pakistan. Since 2016, he has been working as a Teacher with the Department of School Education, Punjab.



HABIB ULLAH KHAN received the Ph.D. degree in management information systems from Leeds Beckett University, U.K. He is currently an Associate Professor of MIS with the Department of Accounting and Information Systems, College of Business and Economics, Qatar University, Qatar. He has nearly 20 years of industry, teaching, and research experience. His research interests include IT adoption, social media, Internet addiction, mobile commerce, computer mediated communication, IT outsourcing big data, and IT security.



ABDUL WAHID KHAN received the Ph.D. degree in computer science from the University of Malakand. He is currently working as an Assistant Professor with UST-Bannu, Pakistan.



SIFFAT ULLAH KHAN received the Ph.D. degree in computer science from Keele University, U.K., in 2011. He was the Head of the Department of Software Engineering, University of Malakand, Pakistan, for a period of three years, where he also served as the Chairman of the Department of Computer Science and IT. He is currently working as an Associate Professor of computer science with the University of Malakand. He is also the Founder and the Leader of the Software Engineering Research Group, University of Malakand. He has successfully supervised ten M.Phil. and four Ph.D. scholars. He has authored over 100 papers, so far, in well-reputed international conferences and journals. His research interests include software outsourcing, empirical software engineering, agile software development, systematic literature review, and software metrics, cloud computing, requirements engineering, and green computing/IT. He received the Gold Medal (Dr. M. N. Azam Prize 2015) from the Pakistan Academy of Sciences in recognition of his research achievements in the field of computer (software).

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