

# A Review and Comparison of the Traditional Collaborative and Online Collaborative Techniques for Requirement Elicitation

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**Abstract**—Requirement elicitation is one of the major phases of the software development life cycle. As per authors knowledge, among many reviews, there is no review available on a comparison between Online Collaborative Requirement Engineering (OCRE) and Traditional Collaborative Requirement Engineering (TCRE) techniques. In this review paper, OCRE and TCRE techniques are reviewed in terms of research methods employed in the related research. In addition, the techniques are compared in terms of software tools used in elicitation of the requirements and the types of software developed by using these techniques. The advantages and disadvantages mentioned in the literature are also highlighted in this research. The relevant papers were selected in a systematic way and data is extracted into the excel files for analysis. The results revealed some interesting findings like the most important techniques in both OCRE and TCRE are literature review followed by experimentation.

**Keywords**—Collaborative, Traditional, Online, Requirement Engineering, Advantages, Disadvantages

## I. REQUIREMENT ENGINEERING

To develop large software, various important phases are required. After determining the feasibility to develop a software, the next important phase is Requirement Engineering or Requirement Elicitation (RE). It is one of the most important stages of software development. Software accuracy and functionality is dependent on this part [1]. The accuracy of the RE depends on the collection of the unambiguous, clear and concise requirements from the end users. Collecting requirements unambiguously, clearly, and concisely is called as Quality RE or QRE.

For QRE, various approaches like introspections, interviews, surveys, questionnaires, focus groups, and joint application development (JAD) etc. are in practice [2]. Among these approaches some are collaborative, and some are non-collaborative. Non-collaborative requirement gathering usually involves a single person to explain and elaborate a specific requirement at a time. Interviews with the customers', end users, questionnaires, and surveys are examples of this approach. Collaborative RE involves two or more people of the same or different domains. They collaborate to enhance requirements, brainstorm for the requirements, and specify the requirements. Focus groups, brainstorming sessions, group storytelling etc. are examples of this approach.

The focus of this research is to review and to compare the online collaborative techniques with the traditional collaborative approaches for RE. The online collaborative approaches though may be similar in nature or by names yet are different in the process. The online approaches use some sort of computer technology/software in the process.

There are various reviews on the RE techniques as well as on the collaborative techniques. For example, [2] and [3] compared various RE techniques and presented the pros and cons of the different techniques. They discussed Ethnography, Joint Application Development, Card Sorting, Repertory Grids, Traditional Techniques, Cognitive Techniques, Contextual Techniques, and Collaborative Techniques in their review. Both [2] and [3] used a literature survey methodology. In addition, in [4] trends of the software development industry are identified up to 2010.

Zowghi and Coulin [5] presented a comprehensive survey of important aspects of the techniques, approaches, and tools for requirements elicitation. They examined the

current issues, trends, and challenges faced by researchers and practitioners in the field. Zhang et al. [6] elaborated on extensive comparison of the requirements development methods and identified common factors that affect the method selection. In addition, the paper also discussed the general guideline that can be used as a starting point for method selection. Anwar and Razali [7] analyzed a number of requirements elicitation techniques and compared them to their effectiveness. In addition, they conducted a survey to know the current practices of RE.

Despite the mentioned researches above and various reviews on RE, no research has focused on the review and comparison between the Traditional Collaborative RE (TCRE) techniques and Online Collaborative RE (OCRE) techniques as per authors' knowledge. In this paper, a review of the research on TCRE and OCRE is conducted. The focus of the paper is on the research methodologies applied in TCRE and OCRE techniques. The paper will further elaborate on the sub-techniques used in each of the TCRE and OCRE techniques as well as brief on the purpose of the technique/sub-technique utilization. In addition, a focus on the advantage and disadvantages of the techniques is also a part of the paper. The type of software that is being used is also discussed. A brief review of both OCRE and TCRE is given below:

The TCRE involve all the requirement elicitation methods in which requirements are gathered or refined involving more than one people in a face to face conversation. Some of the famous techniques are Focus groups, workshops, brainstorming, Joint Application Development (JAD) and prototyping etc. OCRE techniques involve RE methods which again involve more than one people in the process. However, their interaction may not necessarily be face to face. There are many online collaboration tools (wiki blogs) that are available to elicit the requirements from stakeholders. Wiki is web-based collaborative software that allows users to add, remove, and update the contents on a common platform. The rest of the paper is organized as follows: Section II discusses the research methodology and the process of research literature selection in the context of the paper. Section III discusses the methods employed to elaborate on both TCRE and OCRE techniques as well as discusses the similarities and differences of methods between the two techniques. Section IV discusses sub-techniques used in both the TCRE and OCRE. Section V discusses the software/tools in relation to both TCRE and OCRE techniques. Section VI will elaborate on the advantages and disadvantages of both the techniques. Section VII will conclude the paper along with mentioning some open areas to work on.

## II. RESEARCH METHODS

The systematic literature review methodology as advised by Stapic et al. [8] is employed. The methodology includes a review planning followed by keywords identification step as per recommendations by [9]. An inclusion/exclusion criterion for the selection of the relevant literature review is conducted. The research questions are formed from the literature review which is then analyzed in the analysis/review section. The results are presented in the results section. The diagrammatic representation of the methodology is shown in Figure 1. In the process of the review planning, the software requirement engineering related reviews were searched from different databases including major databases like IEEE, Google Scholar, ACM, Elsevier Science Direct, Taylor and Francis, Sage publications, Wiley and Springer etc.

After a comprehensive search and on finding no relevant review on traditional collaborative and online collaborative techniques resulted in the perusal for this review. Furthermore, this review has a scientific value considering the growing use of online and digital technology for the RE process. The practitioners require clear guidelines on the usage and advantages of the traditional collaborative RE approaches and online collaborative RE approaches. The rest of the steps in the process are further explained in the following subsections of this section.

### A. *Keyword Identification:*

Various key research words and their synonyms were identified as a first step here to utilize in search of relevant literature. The keywords like collaborative techniques for requirement engineering, collaborative techniques for requirement elicitation, online collaborative techniques, requirement engineering methods, requirement gathering techniques, requirement specification techniques, requirement engineering collaboration, requirement engineering process etc. The selected keywords were searched in different databases (c.f. section II).

### B. *Inclusion / Exclusion Criteria:*

The search resulted in a list of 323 papers. The papers not published in the English language were filtered resulting in 289 papers. Furthermore, all the papers having none of the keywords in their title or abstract were also filtered out resulting in only 120 papers. In addition, all the papers having the mentioned keywords but not encompassing to the requirement engineering/elicitation were also filtered out. This filtered out papers of the other SE fields like quality assurance, software project management, and software design and architecture etc. The process resulted in a list of 44 research papers that are included in this review.



**Fig. (1).** The research methodology adopted from [8].

### C. Research Questions:

The papers are read via the skimming process initially focusing on their abstracts and conclusions. The aim was to identify some research questions to further elaborate the paper. The process resulted in the following 4 research questions:

RQ-1. Are the research methods to elaborate TCRE techniques different from the research methods used to elaborate OCRE techniques?

RQ-2. Which technique or sub-technique of TCRE or OCRE is mostly used or substantially discussed in the literature?

RQ-3. What are the types of software that are developed by using TCRE and OCRE techniques?

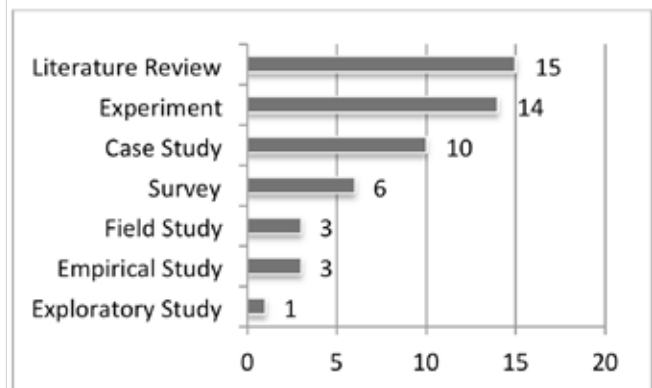
RQ-4. Are the advantages of software development differ in the two techniques or sub-techniques? If yes, then how and in what ways?

### D. Analysis/Review and Results:

The analysis and results make the next three main sections of this research. For simplicity and comprehensibility, both analysis and results are combined into the main sections as follows:

### III. RESEARCH METHODS EMPLOYED TO ELABORATE TCRE, OCRE AND A COMPARISON

To answer the first research question RQ-1, the type of research methods used in the selected papers were extracted as well as the type of strategies employed in the papers. Figure 2 represents the information about research methods.



**Fig. (2).** Research methods employed in the literature related to collaborative RE techniques.

For extracting information related to research methods, either the information embedded directly into the paper was extracted or the research method name was extracted from the method(s) used in the research. It is important to note here that some papers listed more than one research methods. Therefore, the total methods in Figure 2 are more than the total research papers utilized in the process. The description of the research methods and their references in the literature is provided briefly as follows:

#### A. Literature Review:

This category was utilized by 15 research papers out of 44 papers. Out of 15 papers, 8 used only the Literature Review and are [2-3], [5-6], [10-13]. Remaining seven used Literature Review combined with some other method like Survey [7] and [14], Case Study [15-16], Field study [17-18], and Experiment [19].

#### B. Experiment:

Apart from the Literature Review, the experimentation is the second most used methods in RE discipline generally and specifically in both the online and traditional

collaborative RE techniques. The Experiment methods are used by 14 out of 44 papers included in this review. The papers [19-32] used Experimental methods. Only two papers [19] and [32] used the Literature Review and Exploratory Study combined with Experimental methods respectively.

### C. Case Study:

The Case Studies are followed by the 10 research papers. The literature which used case studies are [15-16] and [33-40]. This method is also among the most used methods in collaborative RE techniques.

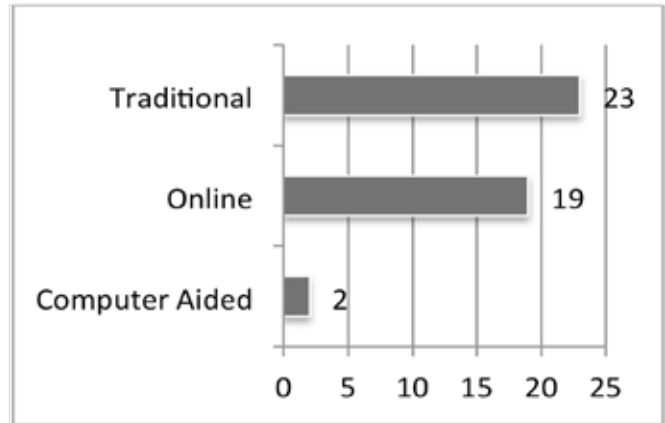
The rest of the methods are used sparingly in the literature pertaining to collaborative RE techniques. For example, Surveys method is used by [4, 7, 14] and [41-43]. The Field Studies are used by [17-18] and [44]. The Empirical Studies conducted by [45-47]. The Exploratory Study is conducted in only [32].

To further elaborate the RQ-1, the selected papers were divided into three overlapping categories i.e. papers that used or discussed TCRE techniques, the papers that used or discussed OCRE techniques and the papers that used Computer-aided collaborative RE techniques.

The TCRE techniques include requirement gathering and specifications via one to one meetings and using traditional pen and paper methods. The OCRE techniques include requirement gathering and specification via online repositories or communication via web, chats etc. In these techniques, some aspects of online communication, storage or requirement retrieval are involved. In the computer-aided technique, the traditional approach is combined with some software tools that help people to record data or could help in organizing minutes of the meeting and projects.

However, these tools do not enable one to communicate online or to communicate with other members. The modes of meetings still would be one to one / face by face meetings. In this way, the technique could fall both in the traditional techniques as well as in the online techniques. However, because there is no online communication via the internet or via some other mechanism, and the members of the group still need to be in proximity, therefore, this technique is closer to traditional techniques as compared to online techniques.

Figure 3 shows that the 23 papers focused on traditional collaborative elicitation techniques whereas 19 papers focused on online collaborative elicitation techniques. Two papers focused on computer-aided collaborative elicitation techniques.



**Fig. (3).** Type of techniques employed in the researches.

On analysis of the related literature regarding TCRE techniques, it was found that the 12 papers highlighted some aspect or angle of the collaborative requirements engineering via a Literature Review, thus highlighting the most used method in the TCRE techniques. However, as literature review provide an overview of the field and is not actually the way of doing the things, the most used method in this sense are Surveys (5), Experiments (4) and Case Studies (4) in combined. In addition, in TCRE techniques, Field Study (2), Empirical Study (1) are also used.

The analysis of the related literature regarding OCRE techniques found that experimentation is the most favoured method of the researchers here. Nine (9) OCRE papers discussed some type of experimentation conducted in the research. In addition, case studies are found to be the second most prevalent method in OCRE techniques with a count of 5. In addition, 3 literature reviews, 2 Empirical Studies, one each of Exploratory Study, Field Study and Survey were also some of the method used in the OCRE techniques. It is worth mentioning here that few papers of both types have used more than one research method.

It is important to note the difference between the TCRE and OCRE techniques here. In TCRE, literature reviews are conducted abundantly whereas they are lacking in the OCRE techniques. The reason might be that the implementation of the TCRE technique is older than the OCRE techniques. The OCRE techniques have recently been introduced with the advancement in the software and hardware technology. Apart from literature reviews, the experimental methods along with case studies are more abundant in OCRE techniques as compared to TCRE techniques.

In the computer-aided techniques, Experiment and the Case Study utilization were found to be conducted in the two papers.

#### IV. MOST USED TECHNIQUES OR SUB-TECHNIQUES OF TCRE AND OCRE

To answer RQ-2, the types of requirement elicitation techniques in the related work were analyzed. For the purpose, type of RE technique(s) utilized in the paper were extracted in an excel file. The file contained the paper name and title in one row and the type of techniques and sub-techniques used in that paper in the rows in front of the paper name. The results revealed a total of 15 sub-techniques used or substantially mentioned two or more times out of 44 related papers. For convenience, these sub-techniques are termed RE techniques or specifically TCRE techniques and OCRE techniques. The most used or discussed RE technique was Joint Application Development (JAD) technique to elicit requirements which were used in 16 papers.

It was followed by Brainstorming 14 times, Prototyping 9 times, Focus Groups 8 times, Requirements Workshops 6 times, Scenarios 4 times, Nominal Group Techniques (NGT), Group Work, Storytelling and EasyWinWin, 3 times each. Whereas, the Integration of JAD and NGT (NJAD), EPMCreate, WikiWinWin, iThink, and Web-based Focus Group were used twice in the related research papers considered in this research. Figure 4 shows the requirements elicitation techniques in the literature related to collaborative RE techniques.

In order to compare the sub-techniques between TCRE and OCRE, only the top 5 most occurring techniques in the

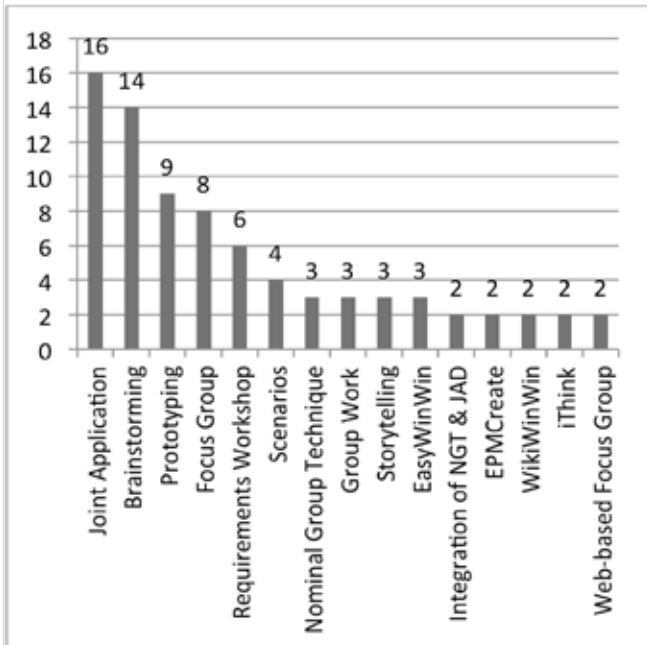


Fig. (4). Type of requirement elicitation techniques in the literature related to collaborative RE techniques.

literature were considered. An analysis of the techniques revealed that JAD is considered most of the times (11 here) in OCRE and only for five (5) times in TCRE. However, TCRE is inclined towards Brainstorming, Prototyping, Focus Groups and Workshops techniques. The reason being that all the above-mentioned techniques require face to face communications. However, JAD could be implemented by sharing parts of the projects or requirement/specification documents on the online systems.

#### V. SOFTWARE/TOOLS RELATION TO TCRE AND OCRE

To answer RQ-3, the software was grouped in two ways.

- Firstly, the type of software or tools that are used to aid the process of TCRE or OCRE. In the related research, such software/tools are already listed and explained in Section IV. There are some processes of RE, where no such tool is used. The examples are Requirements Workshops, Focus Groups etc. However, in some techniques, the software is part of the RE technique. The examples are: EasyWinWin [15], [19] and [37], WikiWinWin [29] and [37], StakeRare [42], iThink [35] and [39] and ThinkLets [34] etc. In addition, related literature such as [32] has also used Facebook in the OCRE process.

- Secondly, the type of software that is the result of a specific requirement elicitation technique. Type of software developed by using either TCRE techniques or OCRE techniques are extracted from the literature are categorized into 6 categories. For example, one of the references [10] developed an online web-based system for distant learning. This system, therefore, was allocated WBS (Web-Based System). Furthermore, the mobile related software was allocated MS (Mobile Software) type, software involving hardware interfacing were allocated HBS (Hardware-Based Systems) and, the software involving distributed process was allocated DSP (Distributed Software Project). In addition, the software involving activities related to buying and selling products were allocated "Sales" type. Furthermore, the software related to providing information is grouped as Information Systems (IS).

From the 44 selected papers, a total of 6 software categories were extracted. The IS type was extracted in most of the related literature i.e. in the 15 (~34%) papers. The list of the papers is [12, 15], [18, 20-21], [26-27], [29, 35, 37], [39-40], [44], [14] and [46]. OCRE techniques were used mostly i.e. 9 times to develop the IS Software whereas TCRE techniques were used for 6 times.

The second most extracted category of software type for RE in the related literature is Web-Based Systems (WBS).

Out of 44 papers, 7 (~16%) paper [22, 24], [37, 41], [42, 45] and [43] discussed this category. The website for education and learning developed by [22, 24] are included. Other web applications like digital libraries, E-market place [37], RALIC [42], Courseware (Multimedia, Computer-aided learning) [41, 43] are also included in the WBS category. In this case [22, 24, 41, 43] used TCRE techniques whereas [37, 42, 45] used OCRE techniques.

For the Mobile applications, [34, 32] used Computer Aided and OCRE techniques respectively. For distributed software, [25, 36] used OCRE techniques whereas Computer Aided [28] and TCRE techniques [47] are used for the sales software. TCRE technique was used for hardware-based software in [38]. The 14 research papers did not mention any specific type of software. Among the research, 11 research papers were related to traditional techniques of requirement elicitation and are literature reviews and 3 papers are related to online RE elicitation techniques.

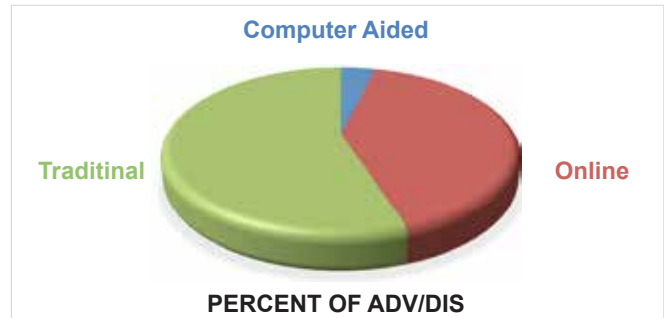
#### VI. ADVANTAGES AND DISADVANTAGES OF TCRE, OCRE AND COMPUTER-AIDED TECHNIQUES

To answer RQ-4, the advantages and disadvantages of TCRE, OCRE and Computer-aided techniques were extracted from the papers ranging from reference [2-47] excluding [8]. The advantages and disadvantages mentioned were extracted in an excel file. A total of 582 records were obtained in this way. Out of the total records, 22 records mentioned advantages/disadvantages of computer-aided requirement elicitation techniques forming only 3.78% of the records. OCRE techniques formed 222 records forming a percentage of 38.14% and TCRE techniques contained 338 records thus forming a percentage of 58.08%. Table 1 shows the details of the record which is extracted from the literature.

**Table 1.** Total Number of Advantages and Disadvantages of Techniques.

Technique Type	Advantages	Disadvantages	Total
Computer Aided	16	6	22
Online	183	39	222
Traditional	193	145	338

The percentage representation is depicted in the following Figure 5.



**Fig. (5).** The share of techniques' advantages/disadvantages mentioned in the literature.

#### A. Distinct Advantages and Disadvantages of Computer-Aided Techniques:

Two references [28, 34] who mentioned computer-aided techniques described the following advantages of computer-aided collaborative requirement elicitation unique techniques:

1. The complete requirements are gathered (x2)
2. High-Quality Requirements are gathered
3. It is easy to use the technique
4. Consensus Building is easy
5. Qualitative Information
6. Gathering of distant Stakeholders
7. Eliminate Ambiguities
8. Validation Support
9. Elicit Nonfunctional Requirements
10. Externalize Tacit Knowledge
11. From informal to defined Use Cases
12. Completeness of Requirements
13. Supports Traceability
14. Simple presentation of Knowledge
15. Easy Asynchronous interactions

The literature also mentioned the following disadvantages as well:

1. Missing Entries
2. Need Skilled Moderator
3. Need E-Tool Administrator
4. Time Consuming
5. Difficult Usability
6. Inaccurate View

#### B. Distinct Advantages and Disadvantages of Online Techniques:

Regarding the OCRE technique, the following unique top advantages are mentioned in the literature in table 2:

**Table 2.** Distinct Advantages of Online Techniques.

Advantages	Count
Easy to use	9
Revision Control	8
Discussion of perspectives	4
Easy sharing of knowledge	4
Identify Stakeholders	4
Voting Facility	4
Anonymity	3
Ease of Access to Information	3
Flexible	3
Motivation of participation	3
Structured group deliberation	3
Supports WinWin Approach	3
All Stakeholders Participation irrespective of Location	2
Allows Updation	2
Check Consistency	2
Common Vocabulary	2
Completeness of Requirements	2
Eliminate Redundancy	2
Enables Semantic interoperability	2
Enforce Equal Participation	2
Externalize Tacit Knowledge	2
Friendly Environment	2
Maintaining History	2
Provide quick Feedback	2
Provide Updated data immediately	2
Recommends Requirements	2
Reduce Cognitive Cost	2
Requirements Categorization	2
Reveal expected Conflicts	2
Suited for Large Softwares	2

The following top disadvantages are mentioned against OCRE techniques in the literature in table 3:

**Table 3.** Distinct Disadvantages of Online Techniques.

Disadvantages	Count
Need Skilled Moderator	3
Time Consuming	3
Depends on participants	2
Low Satisfaction	2
Relatively High Complexity	2

*C. Distinct Advantages and Disadvantages of Traditional Techniques:*

Regarding TCRE techniques, following top unique advantages are mentioned in the literature against the technique in table 4:

**Table 4.** Distinct Advantages of Traditional Techniques.

Advantages	Count
Fast/Good Communication	9
High-Quality Requirements	7
Provide quick Feedback	7

Cost Effective	6
Completeness of Requirements	5
Effective	5
Efficient	5
Negotiate & Resolve issues	5
Satisfaction of Stakeholders	5
Ease of Implementation	4
Generation of New Ideas	4
Reveal expected Conflicts	4
Enforce Equal Participation	3
Natural environment	3
To understand requirements	3
User Commitment	3
Active participation of Stakeholders	2
Comprehensive Technique	2
Discover Requirements	2
Discussion of perspectives	2
Domain Independent	2
Easy evaluation	2
Easy to Learn	2
Effective Group deliberation	2
Eliminate Disputes	2
Flexible	2
Highly Controlled Environment	2
Intuitive	2
Motivate Creative Thinking	2
No Need for Skilled Moderator	2
Produce precise specifications	2
Promote Freethinking	2
Resolves conflicts	2

Furthermore, the following distinct top disadvantages are mentioned in the literature of the TCRE techniques in table 5:

**Table 5.** Distinct Disadvantages of Traditional Techniques.

Disadvantages	Count
Need Skilled Moderator	19
Time Consuming	12
Hardship in Gathering Stakeholders	8
No Freedom	7
Costly	6
Stakeholders Face-to-Face Meeting	6
Biased Opinions	5
Domination among participants	5
Labor Intensive	5
Difficult to Schedule	4
Rigid	4
Dominant Stakeholders	3
Limited Time	3
Uncertainty if no domain knowledge	3
Analysis Cost	2
Demands experience & expertise	2
Ineffective to resolve major issues	2
Participants dependent	2
Political or Social influence	2
User attachment may lead to resistance for an alternate solution	2

## VII. CONCLUSIONS AND FUTURE WORK

In this paper, Online Collaborative Requirement Engineering (OCRE) and Traditional Collaborative Requirement Engineering (TCRE) techniques are reviewed in terms of research methods employed to elaborate on these techniques in the related research. In addition, the techniques are compared in terms of software tools used in elicitation of the techniques and also discussed the types of software that are developed by using these techniques. The advantages and disadvantages mentioned in the literature are also highlighted in this research.

The future work could target other venues of comparison like the explanation of the scenarios in which both techniques are applicable. The type of projects in which these techniques are applicable could also be investigated in details.

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