FRAMEWORK DEVELOPMENT FOR REQUIREMENT NEGOTIATION USING BLOCKCHAIN

by

IQRA JAVED

Supervised By

DR. BASIT SHAHZAD

Submitted for partial fulfillment of the requirements of the degree of MSSE to the
Faculty of Engineering and Computer Science

NATIONAL UNIVERSITY OF MODERN LANGUAGES,

ISLAMABAD

DECEMBER 2020

NATIONAL UNIVERSITY OF MODERN LANGUAGES

FACULTY OF ENGINEERING AND COMPUTER SCIENCE

THESIS AND DEFENSE APPROVAL FORM

The undersigned certify that they have read the following thesis, examined the defense, are satisfied with overall exam performance, and recommend the thesis to the Faculty of Engineering and Computer Sciences.

THESIS TITLE:
FRAMEWORKDEVELOPMENTFORREQUIREMENTNEGOTIATIONUSINGBLOCKCHAIN

Submitted By: Iqra Javed   Registration #: 007 MSSE/Ibd/ F18

Master of Science
Degree Name in Full

Software Engineering
Name of Discipline

Dr. Basit Shahzad
Name of Research Supervisor   Signature: _____

Name of Co-Supervisor (*If Any*)   Signature: _____

Dr. Basit Shahzad
Name of Dean (FE&CS)   Signature: _____

Name of Director General (NUML)   Signature: _____

7th Jan, 2020
(Date)

CANDIDATE DECLARATION

I hereby declare that my MS thesis titled "*Framework Development for Requirement Negotiation Using Blockchain*" is my own work and has not been submitted previously by me for taking any degree from National University of Modern Languages, Islamabad or anywhere else in the country/abroad. At any time if my statement is found to be incorrect even after my graduation, the University has the right to withdraw my MS Degree.

Signature   :   _____

Name   :   _____Iqra Javed_____

Date   :   _____Jan 7th, 2020_____

ABSTRACT

Requirement engineering is the process of defining, documenting and maintaining the requirements. The quality and reliability in requirement engineering process creates quality software projects. These processes operate on different levels of software development to elicitate, negotiate, validate and prioritize the requirements. This elicitation, validation, prioritization and negotiation process lies in requirement negotiation. Several algorithms and techniques are used to gather quality requirements but still there is lack of quality of software projects.

To improve the quality, sustainability and reliability of software project requirement negotiation process needs further enhancement with advanced technology. So the aim of thesis is to introduce an innovative technology blockchain oriented requirements engineering to ensure that the gathered requirements are fulfilling customer wants accurately. The use of blockchain platform in requirement engineering will help to gather correct and complete requirements with efficiency. It will improve the quality of software projects. A framework on blockchain oriented requirement engineering is proposed to overcome the challenges in requirement negotiation. This framework will be proposed by using mixed method research. The mixed method research will validate and justify the blockchain based framework in requirement negotiation.

By implementing blockchain platform in requirement engineering the processes of requirement gathering and validation will fast, easy, according to customer needs and effective moreover the failure rate of projects will be reduced. It will also improve the quality, reliability, and sustainability of software projects and the researchers will easily negotiate for data elicitation and validation and the students will further use this field for better performance of methods and algorithms used in software engineering. The reliability of the requirement negotiation process will also be improved because of the improvement of its factors.

My dissertation work is dedicated to my family and supervisor. A special feeling of gratitude is for my parents who always taught me to work hard with dignity, humility and never lose faith. My supervisor, who is my role model always encouraged me and supports me to follow right path to complete my research work on time.

ACKNOWLEGEMENT

In the start a special thanks to Allah Almighty, All the worships and honor is for him who always helped me to stick to the right path and always provided me the courage and strength to complete my degree with hard work and dedication.

Then I would like to express my special thanks to my most respected supervisor **Dr. Basit Shahzad** who helped me in and encouraged me to complete my assigned tasks on time. He is a very kind person and always motivated me from the start of my thesis. His kind efforts and motivations would never be forgotten and He will always be in my prayers. I feel very proud to work under his supervision and I will always appreciate his efforts and He is my role model.

I would like to thanks all my teachers of National University of Modern languages for conveying their knowledge in many effective ways.

I am highly beholden to my beloved family who is my strength. My parents always encouraged me to achieve my goals and not to fear from failures. They always taught me to use failures to achieve your goals through improvement and work hard until you get success. A special thanks to my brothers who always support me and help me in my work and motivates me whenever I feel stuck.

Finally, I am thankful to the faculty of National University of Modern Languages who has provided a comfortable and friendly environment.

I pray that Allah Almighty give me success in all the chapters of my life and give me ability to work for the betterment of whole world and whole mankind. Aameen

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

SDLC	-	Software Development Lifecycle
CAF	-	Consider All Fact
PMI	-	Plus-Minus-Interesting
SLR	-	Systematic Literature Review
AHP	-	Analytical Hierarchy Process
PG	-	Planning Game
UML	-	Unified Modeling Language
GORE	-	Goal Oriented Requirement Engineering
SLA	-	Service Level Agreement
BS	-	Business Service
RE	-	Requirement Engineering

CHAPTER 1

INTRODUCTION

1.1.   Overview

Requirement engineering identify, document and maintain requirements to produce successful software projects. Many algorithms and techniques are used to make requirement engineering process easier and efficient. These set of processes operates on different levels of software development to gather, analyze, prioritize, validate, document and manage the requirements. These levels can be product, project or organizational level. The main objective of requirement engineering is to interpret and understand the needs, goals and beliefs of stakeholders [1].

However correctively interpreted and gathered requirements help to complete projects successfully according to needs of customer, within given time and estimated budget. So the general purpose of this research is to identify the factors to improve the requirement negotiation process using blockchain-based technology [2]. The quality of requirement elicitation, validation and negotiation process reflects the quality of product. Requirement elicitation is related to various ways used to gain knowledge about the project domain and requirements [3]. The sources of domain knowledge include customers, business manuals and existing software of same type also standards and other stakeholders of the project. The techniques used for requirements elicitation include interviews, brainstorming, task analysis, prototyping, etc. These techniques help gathering and interpreting requirements in more managed and easy ways. To confirm that if these gathered requirements are according to customer needs or not the requirement validation tests are performed. Requirement validation tests are performed to analyze the requirements of customers and other stakeholders. Techniques used in requirement validation process give final result which shows that there is a need of requirements according to software and stakeholders. If some requirements are not necessary or there are some errors in requirements than validation test helps to correct those errors. Techniques used for requirement validation are complex, time consuming and expensive for instance, walkthrough and automated consistency analysis.

The effective development of any project involves software system based on quality of any requirement engineering process [4]. For designing and developing successful projects requirement engineering is primary and one of the most crucial parts because it addresses the designing and developing problems for suitable project, for the customer as well as it allows to create correct time and budget estimation also helps to fulfill needs of customer [5]. Also the consistency of requirements is a question that needs to be answered. While we need to accumulate requirements from multiple sources sometimes in parallel, their synchronization and consistency needs to be ensured. In order to improve the rate of successful projects latest technology should be used in it. The use of innovative technology in requirement engineering processes in all stages of software development lifecycle (SDLC) will improve the performance of projects [6].

Thus blockchain technology is adopted in many organizations and application because of its quality, security and consistency. So to improve the quality of projects and to reduce the failure rate of projects blockchain oriented requirement engineering is discussed which will help to make requirement engineering processes more verified and easy [7]. Blockchain is a secured and distributed ledger technology which provides an immutable record of transactions. Blockchain is a decentralized online global database so its ledger is shared among all the stakeholders [8]. Through the network all transactions are recorded in computer and this ledger is shared by every computer around the world, anyone can access/add these transactions and add transactions but cannot change the ledger after transaction is added [9]. Same like this blockchain is a collection of data and by connecting one block after another in a chronological way each piece of data is added to blockchain. This series of chronologically connected blocks make a chain of blocks so it is called blockchain [10]. The idea of blockchain is now spreading widely in all over the world. The concept of blockchain can now be applied to requirements for trustworthy record management [11].

Blockchain is allowing people to secure digital relationships that were impossible before because data is being disclosed, recorded and secured differently. So the uniqueness of blockchain is that it is secure, immutable, disintermediated and less costly. By using blockchain platform in requirement engineering we can create requirement engineering processes more reliable and accessible moreover it can help gathering consistent data or requirements more easily. The blockchain technology integrates a series of technical systems

with the following characteristics of decentralization, openness, autonomy, anonymity, security and information that cannot be tempered [12].

As we have discussed that quality of project involves that how well its requirements were gathered and fulfilled. But the requirement elicitation is a complex and time consuming task. Though many techniques and algorithms are used to make it easier and efficient but still there is a need of improvement [13]. For this purpose we can use blockchain platforms to make requirement negotiation process more efficient. A framework is introduced for requirement negotiation using blockchain.

By using blockchain platform in requirement engineering we can create requirement engineering processes more secure and it can help gathering data or requirements easily with more consistency and correctness. So the stakeholders can easily contribute/gather authorized requirements easily which will reduce their time and efforts. By introducing blockchain oriented requirement engineering the requirement engineering process will be more efficient, with improved quality of projects and failure rate of projects will also be reduced.

1.2.   Problem Statement

The quality of software project involves that how well its requirements were gathered and fulfilled. Requirement engineering uses many algorithms and processes to gather, validated and negotiate requirements [14]. But the requirement negotiation is a complex and time consuming task [15]. Requirement elicitation and validation process both face challenges which are multidimensional in nature ranging from over centralization to compromised security and synchronization [16]. Further the process is time consuming and produces delays in software development effort. It is vital to propose a mechanism that can overcome these problems by devising a framework for improvement [17].Though many techniques and algorithms are used to make it easy and efficient but still there is a lacking in the quality of projects [18]. Blockchain technology is being adopted in many fields and applications to improve the quality, security, reliability and speed of projects. So we can use blockchain platforms in requirement validation process to gather more accurate requirements. Blockchain oriented requirement engineering will improve the quality and reliability of

projects [19]. By using this technology in requirements negotiation the success rate of software projects is expected to improve.

1.3. Research Questions

Requirement negotiation is a difficult and time consuming process which includes requirement elicitation, validation, prioritization and negotiation. This process of requirement negotiation can be improved by using blockchain based framework.

RQ1: What is the state of art in requirement negotiation?

RQ2: How blockchain based framework can help in improving the requirement negotiation process?

1.4. Research Objectives

According to previous sections it is concluded that requirement negotiation process have lacking in its quality and it should be improved by using blockchain based framework so, the objectives of this research are to study the process of requirement negotiation process which includes requirement elicitation, validation and challenges in requirement negotiation process. The identification of these challenges will help to do find second objective of thesis. Second objective of this research is to study in-depth blockchain based framework and its platforms. Blockchain based applications and frameworks will also be discussed to support the framework. And third objective of this research is to study the strengths and weaknesses of blockchain and how we can you them in framework.

1.5. Methodology

The purpose of requirement engineering is to gather quality requirements to develop quality software products. But software development process needs further improvement due to which requirement elicitation is facing some challenges. A systematic literature review is conducted to gather data through which we have investigated the challenges in requirement negotiation. To validate these challenges a quantitative study is done. And these justified challenges leads to the development of a framework to improve the quality of software

products. We have developed a framework which introduces features of blockchain methods to overcome the challenges in requirement elicitation and validation. By validating this framework through qualitative study or focus group it ensures that the blockchain framework will overcome these challenges effectively.

1.6.   Thesis Organization

In rest of the thesis second chapter is on literature review with the relative work. In literature review requirement negotiation process is explained with its advantages then requirement negotiation process challenges and factors are identified and discussed after that the solution to all the identified factors is added at the end of literature review. The related studies and sources are added with their key factors, advantages and limitation to give a more detailed review. Third chapter presents the methodology of thesis in which the overview of the methodology used is given and then the structure of methodology used is discussed with its advantages, population and purpose the justification. Fourth chapter includes data collection in which data and its explanation from both survey and focused group method is added. The results from both survey and focus group are explained. Fifth chapter includes results and analysis phase in which all the results of both survey and focus group are analyzed and compared with each other and the final result through triangulation process is generated which shows the justification and validation of final result because of reversed method. Last chapter is based on discussion. This chapter includes the answers to all research questions according to final results, contribution of thesis, limitation of work and the future work.

CHAPTER 2

Literature Review

Previous section demonstrates that there are many factors which need to be improved for consistent, reliable and efficient requirement negotiation process and these factors can be improved using blockchain based framework. Many factors are identified in literature review which have lacking in their quality and needs further improvement. Blockchain framework and its features are identified in literature review and a solution is discussed that how a blockchain based framework can be developed to improve the identified factors of requirement negotiation process.

2.1. Systematic Literature Review

In this chapter a literature review is conducted to identify, interpret and evaluate research questions according to available research. A systematic literature review is performed to evaluate the research question and to identify the factors which will help to support the research questions. For proper systematic literature review Kitchenham guideline are followed in this work [20]. In unbiased and thorough way all the existing studies are summarized and a framework will be introduced to improve the existing work in requirement negotiation. It is essential for every organization to fulfill all the functional and non functional requirements of stakeholders because good quality in requirements produces reliable products. For successful software development requirement negotiation process uses many algorithms and techniques [21].

2.2. Overview

Requirement engineering is the process of defining, maintaining and documenting the requirements for successful softwares. It is a process of gathering and defining services provided by the system. However correctively interpreted and gathered requirements help to complete projects successfully according to needs of customer, within given time and estimated budget. Requirement negotiation helps to solve conflicts between stakeholders and to come to an agreement. However in requirement elicitation there are many techniques to

gather quality requirements [22]. But most of the time there is a problem in prioritizing that most important requirements [23]. Requirement elicitation used to gain knowledge about domain knowledge of requirements and the sources of domain knowledge include customers, business manuals, and existing software of same type, standards and other stakeholders of the project [24].

2.3. Factors in requirement negotiation

Requirement negotiation process can be improved by making improvement in its factors. These factors can help to improve reliability and quality of software and also reduce time, budget and efforts utilization on software projects. Factors in requirement negotiation process that requires further improvement are:

2.3.1. Quality

Many expert systems fail because of lack inequality of requirement negotiation process [25]. For designing and developing successful projects requirement negotiation is primary and one of the crucial parts and it addresses designing and developing problems of project for the stakeholders [26]. Software development life cycle is followed by almost every software development organization but still many projects fails due to low quality of softwares.

2.3.2. Social networks

Internet based social media has helped in doing requirement negotiation process with its wide range of data coverage. Social networking is used as the communication interface for planning, software development and removing biasness by using different techniques. Social networks helps to improve several process activities such as stakeholder identification, requirement prioritization, negotiation and requirement gathering [27]. There is a wide range of information on internet but most of the data is placed on websites, this kind of data is unauthorized. So the data should be authorized also data gathering should be easy and the conflicts between stakeholders should be solved. Requirement negotiation is complex and time consuming because in most of the cases there are conflicts between stakeholders for requirement validation and prioritization.

The establishment of requirement negotiation is not an easy process because it is very difficult to identify conflicts between stakeholders and the searching for techniques that how these identified conflicts can be resolved. Than finding the feasible alternatives is also a difficult step. Giving the charge of negotiation to expert is also a difficult decision making process. It is also difficult to know that how we can support the negotiation with tools and other means.

2.3.3. Conflicts in Decision Making

In requirement negotiation all the stakeholders needs to take some important decisions during this process. Though they have a same goal but because of different experiences, needs and thoughts they have conflicts on requirement selection. In software organizations the stakeholders involve in negotiation includes the project managers, customers, developers, suppliers and management of companies. They all have different experiences and needs so theirs conflicts on requirements are also high. Many tools and techniques are used in requirement negotiation process to make decision making process easy but still it is complex and time consuming task. If the final decision fails to satisfy some of the stakeholder than they will take less interest in further decision making process and this will lead to a poor decision making activity [28]. Their conflicts in decision making should be resolved to create quality projects.

2.3.4. Lack of communication

Communication is one of the most important factors in interaction with users and other stakeholders. A good communication can help to sort out many issues and conflicts in negotiation process. Lack of communication is a serious issue in decision making of requirement negotiation process. The requirement negotiation process should involve all of the stakeholder collaboration on same location and same time or at least on same time from different location. But most of the time the stakeholder's communicate from different location and different time which is the reason of bad decision making activities. Some time bad communication skills are also the reason of conflicts because they fail to explain their point of views, experiences and ideas. Because of weak communication gathered requirements are of low quality and this is the common reason of failure of quality software.

2.3.5. **Crowd sourcing**

Crowd sourcing is a model in which organizations or stakeholders share their services, ideas or finances with a large group of internet users. Different organizations assign projects to the developers through internet. The developers send back that project after completion and receive their payment. Crowdsourcing is most widely used all over the world to produce successful projects, to share services, ideas and funds. In crowdsourcing stakeholders and clients work on different time or same time from different location. It is quite essential for all the members of crowdsourcing to negotiate effectively [29]. Requirement negotiation is a complex task in crowds sourcing because it needs the synchronizations of time and location and effective communication. Most of the stakeholders fail to convey their requirements clearly because of which they get an unsuccessful or inappropriate software projects. So the requirement negotiation process also needs more improvement for crowd sourcing [30].

2.3.6. **Consistency of requirements**

Also the consistency of requirements is a question that needs to be considered. Requirements should be both logically and strategically consistent. Requirements must not be repeated and must be clear and understandable. Good requirements are well prioritized according to their functional and nonfunctional criteria. While we need to accumulate requirement from multiple sources in parallel, their synchronization and consistency needs to be ensured.

2.3.7. **Requirement Validation**

To check that if these gathered requirements are correct, complete and according to the needs of stakeholders, validation tests are performed on requirements. These requirement validation techniques ensure that the gathered requirements are according to the demands of stakeholders. If there are some errors in gathered requirements than validation will help to correct them and protect the software project from defects after deployment. Requirement validation is the most important phase after requirement gathering. Because in requirement gathering there are lots of useless requirements which increase the complexity of system so to gather complete and correct requirements validation phase is essential [31]. Several

techniques are used for requirement validation but because of errors in requirement negotiation process the gathered requirements are not fully according to the needs of all of the stakeholders. Some time because of excessive amount of requirements, repeated requirements or useless/ nonproductive requirements the validation test fails to validate all the requirements precisely and effectively. So the requirement validation process and its techniques need to be more efficient to validate large amount of inconsistent and non-prioritized requirements.

2.3.8. **Requirement Negotiation**

Requirement negotiation is to define mutually satisfactory requirements on which all the stakeholders are agreed. Because of rapid changes in the market the requirement negotiation helps to make changes according to stakeholder's updated requirements at any phase of SDLC. Requirement negotiation should be repeated in later stages of requirement engineering process. Different tools are used for requirement negotiation some of them are passive support, active facilitative support and pro-active interventive support tool. Passive tools support all collaboration situations by providing infrastructure for negotiation. All the parties express their views and ideas and collaborate through email, multimedia rooms or chat etc. Active facilitated support tools help the stakeholders to come to an agreement for example for mutual gain it identifies the situation. This tool helps in evaluation, formulation and problem solving. Pro-active interventive support tools coordinate the activities of stakeholders. These tools critically analyze the actions of stakeholders and help them to come to an agreement.

In requirement negotiation there is a mutual interaction between all the stakeholders. They negotiate on all the requirements and the requirements on which all the stakeholders are agreed are used in creating a project. Because of large amount of requirements it is difficult to negotiate on each requirement under specific budget and time [32]. Two different dimensions of requirement negotiation are discussed that helps to solve conflicts between stakeholders, collaboration between stakeholders and the tools that are used for solving problems. These dimensions are:

2.3.8.1.   **Conflict resolution strategy**

It is very important to resolve the conflicts between stakeholders because if any party is not satisfied with the resolved conflict than there will be a lack of interest in stakeholders engagement. This will leads to the failure of project. When conflicts are resolved by all stakeholders than the selected requirements will be authorized and the developed project will be according to needs of stakeholders also it will lead to the success of project. There are many kinds of conflict resolution techniques some of them are:

a) Qualitative conflict resolution techniques

In this technique the stakeholders come up with mutually selected requirements after negotiation through some methods. The methods used in qualitative conflict resolution are:

- Agreement: To negotiate a solution to solve conflicts the stakeholders work together which includes the discussions about views of each stakeholder to come to an agreement.
- Compromise: In this technique all the stakeholders compromise on an acceptable solution which is generated after analysis of various solutions.
- Voting: In this technique the stakeholders simply vote in favor of the solution or against to that solution. And the solution with high votes will be selected as the best solution.
- Definition of variants: In this technique the preferred solution by stakeholders is implemented after applying their own variants to the solution parameters. This is a qualitative technique [33].
b) Quantitative conflict resolution techniques
- Overruling: In this technique the solution of most senior stakeholder is taken as the final resolution. This technique works as the hierarchy of organizations. This is a quantitative technique.
- Consider all fact (CAF): In this technique all the facts about specific conflicted requirement are considered and then prioritized in a readiness to be used as an input to "Plus-Minus-Interesting" or PMI technique.
- Plus-Minus-Interesting: All the positive and negative repercussions of solutions alternative are analyzed in this technique. Two categories, one for Plus and one for Minus are developed in order to list the positive and Negatives. When a fact is neither a positive nor a negative item, it is placed in the interesting column.

- Decision Matrix: Decision matrix consists of comparison matrix of all key criteria to resolve a requirement conflict. This key criteria needs to be consider against each solution alternative. The comparison of information in matrix highlights the best solution of conflicts.

2.3.8.2. **Collaboration situation**

In this dimension of requirement negotiation all the stakeholders interconnect with each other for which their time and location negotiates. The collaboration can be synchronous or asynchronous. In synchronization negotiation stakeholders work together face to face but in asynchronous negotiation stakeholders collaborate from different locations on different time which is a difficult stage. The collaboration situation is divided into four types:

- Same time same location: The stakeholders collaborate with each other on same time and location. The face to face communication helps them to communicate with each other easily.
- Different time same location: The stakeholders collaborate face to face but their timings are different from each other. Due to which all of the stakeholders cannot collaborate o same time.
- Same time different location: The stakeholders collaborate with each other on same time but from different location. Due to the communication gap they face many problems and the rate of conflict between them is high.
- Different time different location: The stakeholders collaborate with each other in different time and from different location due to the communication gap and different timing conflicts arises.

These requirement negotiation strategies are used to make the requirement elicitation and validation process more easy and validated but still there is a need to improve time, budget and effort utilization in these strategies with the innovative technology. Because there is a time and communication problems which exceeds the specific budget during requirement negotiation process the failure rate of projects increases. The use of latest technology will increase the performance and help to produce successful projects efficiently [34].

2.4.   Systematic Literature Review Protocol

To conduct systematic literature review six steps are followed according to Kitchenham guidelines. These steps help to get right results in a proper way. In first step we have figured out the research questions. The formulation of research question helps to explore the relevant research on specific area or topic.

```
                    ┌───────────────────┐
                    │     Research      │
                    └───────────────────┘
                             │
                    ┌───────────────────┐
                    │ Research Questions │
                    └───────────────────┘
                             │
                    ┌───────────────────┐
                    │   Search String   │
                    └───────────────────┘
                             │
                    ┌───────────────────┐
                    │   Search Source   │
                    └───────────────────┘
                             │
                    ┌───────────────────┐
                    │   Search Process  │
                    └───────────────────┘
                             │
                    ┌───────────────────┐
                    │     Inclusion/    │
                    │     Exclusion     │
                    └───────────────────┘
                             │
                    ┌───────────────────┐
                    │      Quality      │
                    │    Assessment     │
                    └───────────────────┘
                             │
                    ┌───────────────────┐
                    │  Data Collection  │
                    └───────────────────┘
                             │
                    ┌───────────────────┐
                    │ Accurate Results& │
                    │     Analysis      │
                    └───────────────────┘
```
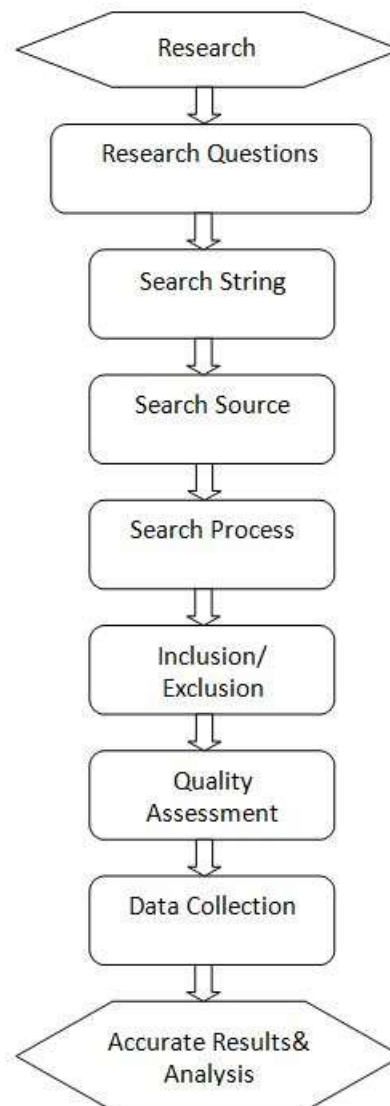
Figure 2. 1: Systematic Literature Review

After that in next step search string is generated by technical ways from relevant research studies. Related to problem statement the relevant studies were gathered from different research databases. Many relevant research studies were gathered for literature

review but some of them were not precisely relevant. So, to get more relevant research studies an inclusion and exclusion criteria was set for more filtration of gathered studies. To ensure the quality of research studies after filtration process quality assessment criteria was set. This quality assessment criteria shows that the related studies are more accurate to answer the research question.

2.4.1. Research Question

The main focus of this research is to study the process of requirement negotiation; to study in-depth blockchain based framework and its platforms further to study the strengths and weaknesses of blockchain also how we can you them in framework.

RQ1: What is the state of art in requirement negotiation?

RQ2: How blockchain based framework can help in improving the requirement negotiation process?

2.4.2. Search Process

To search the relevant studies for research questions search strings are generated which shows the related results according to the search queries. The search string helps to find out the factors of requirement negotiation process and which factors can further be improved. Search query also helps to identify the framework of blockchain technology and its strengths and weaknesses. Search is done through different electronic platforms. Some of them are IEEE digital library, ACM, Science Direct, Springer and Google Scholar. Advanced techniques are applied on search strings which are Boolean operators, bracket, AND operators to make the process of searching more accurate.

Search strings for RQ1 are derived from simple keywords these keywords help to create a specific search string according to relevant study.

1. Keywords for **RQ1**:
   - Requirement engineering process
   - Requirement negotiation process
   - Requirement negotiation factors
   - Requirement negotiation techniques
2. Search Strings for **RQ1**:
   - ((Requirement Engineering) AND Process)

- ((Requirement Negotiation) AND Process)
- ((Requirement Negotiation) AND Factors)
- ((Requirement Negotiation) AND Techniques)

Search strings for RQ2 are derived from simple keywords:

3. Keywords for **RQ2**:
- Blockchain based applications
- Blockchain types
- Blockchain platforms
- Blockchain applications
- Blockchain projects

4. Search strings for **RQ2** are:
- ((Blockchain) AND Applications)
- ((Blockchain) AND Types)
- ((Blockchain) AND platforms)
- ((Blockchain) AND projects)
- ((Blockchain) AND software engineering)

2.4.3. **Inclusion and Exclusion Criteria**

The main focus of our study is requirement negotiation and blockchain implementation. For this purpose the specific inclusion and criteria is set to gain the results according to focused topic.

1. Inclusion Criteria

To find the most relevant research about research questions the inclusion criteria focus on titles of research papers, keywords and their abstract. The paper must be

- Written in English language.
- Discuss requirement negotiation process.
- Discuss requirement negotiation techniques and factors.
- Discuss limitations in requirement negotiation process and techniques.
- Discussing the technical aspects of requirement negotiation process.
- Paper which discusses blockchain technology.

- Paper which explains the platforms of blockchain.

- Paper which discusses strengths and weaknesses of blockchain.

- Paper that discusses the use of blockchain in applications and software engineering.

- Papers in domain or requirement engineering and blockchain technology from 2016 to 2020.

- Having basic information and history the old papers can be consider.

- Papers that have the potential to answer any of research questions of thesis.

2.   Exclusion Criteria

To make the search more accurate the exclusion criteria should be on these limitations.

- Research paper not in English language.

- Articles which are published on unauthorized or other websites other than digital libraries.

- Research papers which are totally redundant for our topic.

- Papers which are not relevant to research questions.

- Grey papers which are not published yet or published in any non-commercial or unauthorized form.

2.4.4. **Quality Assessment Criteria**

To evaluate the quality of research study a quality assessment criteria is defined. This assessment criterion asks different questions for the assessment of quality of research. These research questions have their options which are yes, no, can't tell and not applicable. To find out the related research and to add these studies in SLR this assessment criteria is followed.

2.4.5. **Data Collection**

There are many methods for data collection but most widely used data collection method is to use software tools for data collection some of them are endnote, zotero and mendeley. Data is collected in this research using Mendeley. The process of data collection only covers the research question and added only relevant research studies which are able to support or answer the research questions.

2.4.6. **Search Result**

According to research question 1 the studies searched are listed in below table. These studies are related to requirement engineering process, its factors and challenges. The search queries are generated on different search engines.

Topic: Requirement Engineering Process

Keywords: Requirement Engineering, process

Search query: ((Requirement Engineering) AND Process)

Table 2. 1 Search results for Keyword 1

Database Names	No of results
IEEE	329
ACM	63,486
Science direct	686, 273
Springer	796,973

Topic: Requirement Negotiation Process

Keywords: Requirement Negotiation

Search query: (Requirement Negotiation)

Table 2. 2 Search results for Keyword 2

Database Names	No of results
IEEE	831
ACM	479, 422
Science direct	61,716
Springer	14

Topic: Types of blockchain

Keywords: Blockchain, types

Search query: ((Blockchain) AND Types)

Table 2. 3 Search results for Keyword 3

Database Names	No of results
IEEE	89
ACM	44
Science direct	702
Springer	1,522

The search result added in below table 2.4, are related to blockchain platforms and frameworks. These blockchain platforms and frameworks will help to better understand the blockchain frameworks. These studies will further be filtered by using inclusion exclusion criteria.

Topic: Platforms of blockchain

Keywords: Blockchain, platform

Search query: ((Blockchain) AND Platforms)

Table 2. 4 Search results for Keyword 4

Database Names	No of results
IEEE	284
ACM	76
Science direct	702
Springer	1,522

The search result in below table 2.5 are supporting research question 2. In these research papers the applications based on blockchain are discussed and introduced.

Topic: Applications of blockchain

Keywords: Blockchain, Applications

Search query: ((Blockchain) AND Applications)

Table 2. 5 Search results for Keyword 5

Database Names	No of results
IEEE	626
ACM	222
Science direct	880
Springer	2,115

According to research question 2 blockchain roles and implementation in software engineering are identified in below table. These papers will help to find out the solution to research objectives and will further be filtered by using inclusion and exclusion criteria.

Topic: Blockchain role in software engineering

Keywords: Blockchain, Software engineering

Search query: ((Blockchain) AND software engineering)

Table 2. 6 Search results for Keyword 6

Database Names	No of results
IEEE	668
ACM	1,651
Science direct	1,688
Springer	4,211

The details about different requirement engineering and negotiation processes are added in the Table 2.7 which is given below. The name of author, year, limitation, key factors

and advantages of research study are given in the result which is in Table 2.7 bibliographic analysis.

2.4.7. **Outcome of Systematic Literature review**

By conducting a systematic literature review the relevant research studies are added in the research tool mendeley which helped to answer all the questions of research. The systematic literature review helped to identify the factors of requirement negotiation process and how these factors can be improved. SLR also helped to identify the frameworks which can be implemented in requirement negotiation process to improve its factors. SLR helped to review the blockchain technology and its platforms. SLR also helped to identify the strengths and weaknesses of blockchain frameworks and how it can be used to improve the requirement negotiation process. The studies gathered for literature review are divided in five parts. These five parts are studies on requirement engineering, requirement negotiation, requirement engineering risk factors, platform of blockchain and blockchain based-applications.

This thorough literature review helped to take in-depth knowledge of factors and risks in requirement elicitation and validation process. It also helped to identify the platforms, features and applications of blockchain technology. The development of framework is a challenging task for requirement negotiation but literature review helped to introduce a framework based on blockchain technology which will reduce the challenges in requirement negotiation process and also reduce the risks in software projects.

Related studies are given in Table 2.7 to show the understanding of requirement engineering and its processes. Requirement engineering techniques, practices and methods are listed with their key factors, advantages and limitations. In papers listed below have many limitations which are security issues synchronization, low level projects, human error, biasness, prioritization, time consumption, undefined requirements, validation and elicitation of requirements in softwares.

Table 2. 7: Bibliomatric Analysis of Requirement Engineering

Paper #	Title	Author	Key Factors	Advantages	Limitations	Year
1.	Engineering and Managing Software Requirements nnnn	Aurum, Aybüke Wohlin, Claes	Need of improving requirement engineering, negotiation process	Help in pin pointing requirement negotiation process.	Role of moderator is a human being, High chance of human error, Not secure	2005
2.	Efficient requirement engineering for small scale project by using UML [8]	Saeed, Muhammad Sajjad Sarwar, Nadeem Bilal, Muhammad	A module based integrated model is proposed, and demonstrated with UML modeling	Produce a quality product.	Not synchronized, Techniques can't be applied to all expert systems, requirement not defined properly	2017
3.	Customization of requirement engineering best practices for Pakistan software industry [9]	Riaz, Muhammad Qasim Fateh-Ur-Rehman, Maqbool, Bilal Butt, Wasi Haider	Customized requirement engineering practices followed by the software development organization of Pakistan.	Help us to understand the gaps in the requirement engineering process of Pakistan's organizations and other developing countries.	Not prioritize efficiently, Time consuming	2018
4.	Goal oriented requirement engineering: A critical study of techniques [11]	Anwer Shahzad, Ikram Naveed	Synthesizes the underlying concepts of GORE with respect to coverage of requirement engineering activities	Make requirements clear	Not for large projects, Not synchronized, Time consuming	2006
5.	A Model-Driven Goal-Oriented Requirement Engineering Approach for	Mazón, Jose-Norberto, Pardillo, Jesús, Trujillo, Juan	How to model goals and information requirements for data warehouses, and	Helps to provides the required information to support the decision making process	Not synchronized , Techniques can't be applied to all expert systems, Requirement not	2007

	Data Warehouses [25]		how to derive a conceptual multidimensional model		defined properly	
6.	Requirements engineering: A Roadmap [29]	Nuseibeh, Bashar Easterbrook, Steve M.	Better modeling and analysis of problem domains, Development of richer models for capturing and analyzing non-functional requirements.	Helps to find out overview of software system requirement engineering. Helps to find challenges in software engineering.	Not prioritize efficiently, Time consuming	2000
7.	An effective requirement engineering process model for software development and requirements management [38]	Pandey, Dhirendra Suman, U. Ramani, A. K.	Model implementation for successful software development and requirement management	Helps to produce quality in software products by its model	Other elicitation techniques can also be used requirement validation is not used	2010
8.	CaRE: A Refinement Calculus for Requirements Engineering Based on Argumentation Semantics	Yehia Elrakaiby, Alessio Ferrari, John Mylopoulos	Propose a refinement calculus for requirements engineering (Care) for gathering accurate requirements	Helps to refine to create accurate unambiguous and complete requirements	Lacks proper semantics, Not a cost effective evaluation	2018
9.	Goal-Oriented Requirements Enginering: A Roundtrip from Research to Practice [33]	Axel van Lamsweerde	Adding goals in requirement negotiation process	To improve the quality of requirement negotiation	Progress in RE activities are felt to be harder to measure, the benefits of using RE technologies are felt to be hard to measure, requirements documents are generally perceived as big, complex, outdated, and too far away from the executable products customers are paying for	2004

Requirement Negotiation related studies are listed in Table 2.8. Factors in requirement engineering are listed in this table 2.8. In which different requirement negotiation techniques and methods are listed with their advantages and limitations. The limitations include centralization, applications not capable to handle large amount of requirements, time consumption, synchronization, negotiation, trust issue, integration, relationship between stakeholders and conflicts between stakeholders. These papers support research question 1. In which factors and challenges in requirement negotiation are identified by literature review which is listed in below table.

Table 2. 8: Bibliomatric Analysis of Requirement Negotiation

Paper #	Title	Author	Key Factors	Advantages	Limitations	Year
1.	Effectiveness of RequirementPrioritizationUsingAnalyticalHierarchyProcess (AHP) And PlanningGame (PG): A ComparativeStudy [4]	Siddiqui, Shadab Beg, Mohd Fatima, Shahin	The results reveal that the intuitive and quick PG technique is superior to AHP technique.	Two techniques of requirement prioritization are described which help in making requirement negotiation.	Other models are neglected, Time consuming, Changeable, Centralized	2013
2.	7 Requirements Negotiation [51]	Grünbacher, Paul Seyff, Norbert	To motivate the need for negotiation in requirements engineering to introduce fundamental concepts and terminology, and to provide an overview about negotiation research	Presenting a general negotiation process, typical negotiation stages. Framework covering important dimensions of requirements negotiation comprising the conflict resolution strategy, the collaboration situation of the stakeholders, and the degree of negotiation tool support discussing and classifying	Not for large projects, Not synchronized, Time consuming	2005

				existing negotiation tools using the general process and framework		
3.	Decision Problems in Requirements Negotiations Identifying the Underlying Structures [44]	A.Lenz, Annika	Identifies decision problem structures in software requirements negotiations using a literature-based research approach	Helps to select appropriate scenarios of decision problem structures in software requirements negotiations	Not for large projects, Not synchronized, Time consuming	2017
4.	Requirements Negotiation [50]	Fernandes, João M	Explains requirement negotiation process and its dimensions	Helps to identify the purpose of doing requirement negotiation	Not synchronized, Techniques can't be applied to all expert systems, requirement not defined properly	2016
5.	A Framework for Dynamic eBusiness Negotiation Processes [6]	JinBaek Kim	To create requirement negotiation process systematic	Systematic requirements Prioritize requirements	Time consuming	2003
6.	A replicable web-based negotiation server for ecommerce [7]	Stanley Y. W. Su, Chunbo Huang Joachim Hammer	Introduce replicable web based framework	To create bargaining type negotiating process easier with framework	Complex and time and efforts consuming	2000
7.	A Requirements Maturity Measurement Approach Based on SKLSEWiki [75]	Rong PENG Qiang YE, Mao YE	Concept requirement maturity is proposed to give degree to requirements	Prioritize requirements by gives maturity level	We should use Approach improvement. Stability analysis, Large-scale trial Usage extension	2010
8.	A Requirements Negotiation Model Based on Multi-Criteria Analysis [76]	Hoh In, David Olson, Tom Rodgers	Offer useful tools to aid stakeholders negotiation process	Help in ranking the requirements	Option generation and negotiation planning, Criteria exploration and objective assessment for option score and criteria	2000

					weight, systematic post-analysis for agreement and graphical Support	
9.	Agent-based SLA negotiation protocol for cloud computing [31]	Ramsha Baig, Waqas A. Khan, Irfan ulHaq, Irfan Muhammad Khan	Propose a formal model of Service Level Agreement (SLA) based negotiations	Allow agent-based multi round SLA negotiation for making dynamic offers influenced by varying client requirements, different pricing model and decision strategies	Multiple rules, multiple providers, multiple rounds, complex, Not dynamic and customized	2017
10.	An Automatic Requirements Negotiation Approach for Business Services [77]	Eric Dubois, Kyriakos Kritikos, Sylvain Kubicki	Proposes a broker-based BS negotiation framework that can automatically determine the non-functional requirements	Helps to determine non functional requirements and create difference between functional and non functional requirements	Integration of this work with a BS composition approach	2011
11.	An Efficient and Minimum Sensitivity Cost Negotiation Strategy in Automated Trust Negotiation [79]	Yan He, Miaoliang Zhu, Chunying Zheng	The policies participating trust negotiation is modeled as a Negotiation Petri Net and a trust negotiation MSC strategy is propose	To use for secure requirements in which user can trust that they are best	Complete trust negotiation model, which includes credential and policy rules, the trust negotiation strategies, consistency detectors, etc, will be built for the project	2008
12.	Collaborative Requirements Negotiation with EasyWinWin	Paul Gruenbacher	Easy WinWin has been successfully applied to real-client custom development projects	Improved involvement and interaction Dejined process, Support for duerent collaboration scenarios, Improved prioritization and elaboration of issues	Not efficient with latest technology	2000
13.	Comparison of Requirements Hand-Off,	Samuel Fricker, Martin Glinz	Evaluated the relative effect of requirements hand-off,	Ease challenges in the collaboration between marketing	Address the understanding of requirements	2010

	Analysis, and Negotiation: Case Study [27]		analysis, and negotiation on requirements and design volatility and on requirements understanding	and development	communication by evaluating the product manager's evolving requirements understanding	
14.	Enhancing GSS-based Requirements Negotiation with Distributed and Mobile Tools [32]	Norbert Seyff, Christoph Hoyer, Erich Kroiher, Paul Grünbacher	Research in distributed and mobile requirement negotiation, describe the Easy WinWin, identify issues in face-to-face negotiations	Overcome issues with distributed and mobile tools. Broadband face-to-face interactions, Distributed ARENA II tool provides sufficient support for distributed teams	Complete, correct, and consistent requirements, Quality of the gathered requirements need to be evaluated	2005
15.	Interest Based Learning Activity Negotiation [34]	Xuehong Tao, Yuan Miao	Proposed an interest based learning activity negotiation system	Negotiation learning content/activity plays an important role in effective learning, learners will have more opportunities to learn in a personalized style and with adaptive content	Needs adoption of other knowledge models like cognitive maps, or Bayesian networks	2008
16.	Mobile Speech Translationfor Multilingual Requirements Meetings: A Preliminary Study [35]	Fabio Calefato, Filippo Lanubile, Damiano Romita, Rafael Prikladnicki, João Henrique Stocker Pinto	To overcome language problems among stakeholders who are remotely negotiating software requirements speech recognition and machine translation are combined to generate mobile speech translator.	Overcome language gap	Results are not confirmed	2014
17.	Negotiating Service	Tuoye Xu, Tong Li,	Automated service	Negotiators can choose different	Develop negotiation	2010

		negotiation framework is introduced, in this parties as negotiators are involved, who negotiate to reach agreement.	negotiation strategies according to their preference and their requirements and preference.	mechanism experimental service platform, called Safary,	
	Requirements among Strategic Actor [63]	Lin Liu, Barrett R. Bryant			
18.	Negotiation in the Requirements Elicitation and Analysis Process [2]	Sabrina Ahmad	Introduced negotiation spiral model	Well aligned requirements by all the stakeholders, improved system quality, a sound basis for resource estimation and less resource wastage	Negotiation process because of tacit individual and undeclared perspectives perceptions will lead a sub optimal set of requirements	2008
19.	Process Implications of Social Networking-Based Requirements Negotiation Tools [40]	Nupul Kukreja, Barry Boehms	Introduced Winbook with a social networking based way of capturing, negotiating.	Improve the requirement negotiation process	Time consuming	2012
20.	Reasoning about Stakeholder Groups for Requirements Negotiation based on Power Relationships [46]	Hui Yang, Peng Liang	Make use of the basic principles of requirements negotiation and define reasoning rules to reason about stakeholder groups for requirements negotiation, based on an extended i* modeling framework	Improve power relationship between stakeholders.	Still there are challenges which effects power relationship between stakeholders	2013
21.	Reframing Societal Discourse as Requirements Negotiation: Vision Statement [43]	Kurt Schneider, Oliver Karras, Anne Finger, and Barbara Zibell	Discourse is reframed as a requirements process, suggest using techniques of requirements engineering (RE) and Crowd RE,	With the explicit goal to state software, hardware, and organizational requirements, getting stakeholders involved	Can be used directly for developing innovative software, which will speed up the implementation of a	2017

			propose video as a medium for communicating problems		decision	
22.	Requirements Negotiation for Multilayer System Components [48]	Juan Pablo Carvallo, Xavier Franch	Presenting a software quality models as framework to support the negotiation of both initial and rising requirements and the settlement of stakeholders' concerns	Approach supporting requirement negotiation between stakeholders and solving their conflicts	The approach did not present significant drawbacks.	2011
23.	Requirements Negotiation Model: A Social Oriented Approach for Software Ecosystems Evolution [36]	George Valença , Centro de Informática	How requirements negotiation collaborates to ecosystem's health and success, defining negotiation strategies along Software Ecosystem evolution considering the Software Platform Management	To develop improved quality software ecosystems	Not discussed the results after implementation	2013
24.	RGSS-Negotiation: A Genetic-Based Approach for Web Service Security Negotiation [21]	Amira Abdelatey, Mohamed Elkawkagy, Ashraf Be. El-Sisi, Arabi Keshk	An automated genetic based approach for security negotiation among services is conducted	Improving security, to get an acceptable security level for both sides	Securing only the web service and not covering all the conditions of web service	2016
25.	Software Requirements Negotiation: Some Lessons Learned [41]	Barry Boehm, Alexander Egyed	Using an instrumented version of the USC WinWin groupware system	To increase quality of requirements	Not suitable for latest technology based negotiation	1998
26.	Tailoring Requirements Negotiation to	Norbert Seyff, Stefanie Betz, Leticia	Extended the WinWin Negotiation Model by	Includes the ability to consider the impact of requirements on	Further validate the initial findings and answer open	2018

		Duboc, Colin C. Venters, Christoph Becker, Ruzanna Chitchyan , Birgit Penzenstadler, Markus Nöbauer	incorporating sustainability concepts	sustainability also allows practitioners to reflect on requirements and their effects on sustainability	questions	
	Sustainability [47]					
27.	Trust Vector-Based Sensitive Information Protecting Scheme in Automatic Trust Negotiation [10]	Jian-yun LEI, Bing-cai ZHANG, Xiao-hai FANG	A trust vector based sensitive information protecting scheme is presented based on the existing schemes.	Recovers bugs, improved reliability	No very efficient according to the advancement in technology	2011
28.	Winbook: A Social Networking Based Framework for Collaborative Requirements Elicitation and WinWin Negotiations [42]	Nupul Kukreja	Collaborative requirements elicitation and management	Way people collaborate on Facebook and organize their emails on Gmail to come up with a social networking-like platform to help achieve better usage of the winwin negotiation framework	Could use with a relatively low learning curve and continually monitor the commitment status of the teams	2012

In requirement engineering there are many risks and lacking in methods of requirements engineering because of which software success rate is less than its production. These lacking and risks are studies and listed in Table 2.9 with their limitations. The risk identified in papers which are listed below helps to improve the performance of project and to give important aspects to focus on.

Table 2. 9: Bibliomatric Analysis of Requirement Engineering Risk factors

Paper #	Title	Author	Key Factors	Advantages	Limitations	Year
1.	Top ten lists of software project risks: Evidence from the literature survey [30]	Arnuphaptrairong, Tharwon	Investigate common risk factors and proposed the top ten lists of software risks	Helps in project planning and control purposes during the project execution.	Repetitions in model, Not secure, Complex	2011
2.	Expert system and it's requirement engineering process [37]	Agarwal, Mahak Goel, Shivani	Basic introduction of expert systems consisting of their composition, and basic characteristics and advantages	Helps in selecting good and appropriate techniques during requirement engineering process is important.	Techniques discussed are time consuming, Not secure	2014
3.	A social network based process to minimize in-group biasedness during requirement engineering [39]	Mughal, Shuja, Abbas, Assad Ahmad, Naveed Khan, Samee U.	Address the biasness problem while identifying and prioritizing stakeholders	Identified the stakeholders and their requirements more efficaciously prioritized the stakeholders significantly	Not covering all the application areas	2018
4.	Do family risk factors influence Attention Deficit Hyperactivity Disorder via disruption of neurocognitive functioning? [78]	Miller, TorriWynette	Blockchain architecture as a new system solution to supply a reliable mechanism for secure and efficient medical record exchanges	Revolutionize the e- Health industry with greater efficiency by eliminating many of the intermediates	Not prioritize efficiently, Time consuming	2010
5.	Requirements Reasoning for Distributed Requirements Analysis using Semantic Wiki [52]	Peng Liang, Paris Avgeriou, Viktor Clerc	Focus on the reasoning support which is not fairly addressed by existing semantic wikis	To help find requirements which are complex and different from all requirements	Cost and time effectiveness	2009
6.	Software Risk Management	Hassan I. Mathkour,	Providing knowledge about	Strategies are provided to reduce	Strategies are provided for	2011

	and Avoidance Strategy [24]	Basit Shahzad, Sami Al-Wakeel	handling risk factors occurring in software development	risk factors	comprehensive list of risk factors	
7.	Identification and Quantitative Analysis of Project Success Factors for Large Scale Projects [3]	Basit Shahzad, Abass Md Said	Software project factors are identified, prioritized and discussed in this research	Most important factors for software success are cost, time and effort	Data is not gathered from latest projects success rate	2014
8.	Identification of Patterns in Failure of Software Projects [13]	Basit Shahzad, Kinza Mehrawan, M. Ikram-ullahLali, Waqar Aslam	Categories of risks according to their dimensions are identified, listed and discussed	Helps to identify that budget, time and complexity of process are most important factors to improve	These identified risks can further be handled with latest technologies	2017
9.	Build Software or Buy: A Study on Developing Large Scale Software [12]	Basit Shahzad, Abdul latif M. Abdul latif, Naveed Ikram, Atif Mashkoor	Factors are identified for both build versus buy software	Factors defines that in both build and buy software cases needs improvement	Applicable on limited types of software	2017
10.	Enhanced RiskAnalysis-Relative Impact Factorization [22]	Basit Shahzad, Tanveer Afzal, Rizwana Irfan	Determines relative impact of risk factors on the software development activities.	Relative impact ratio ensures to determine the direct and indirect impacts of a risk on all activities of software development.	Risks factors can be better identified, and by using the using the avoidance strategies, they can be better avoided.	2005
11.	Software Risk Identification and Mitigation in Incremental Model [26]	Ahsanullah, Basit Shahzad, Naveed Khan	A thorough handling and avoidance strategy is proposed for the identification of risk factors when the incremental model is used for software development	Advised strategies are expected to provide a helping hand for the avoidance or mitigation of a risk factor	Identified risk factors may grow in future and so can be the mitigation and avoidance strategies	2009
12.	Risk Management Approaches for Large Scale	Sheikh Tahir Bakhsh, Basit Shahzad,	Propose a Risk Reduction Model that minimizes risk	Minimize risks, budget, resources and time	Not applicable for small scale projects	2017

	Software Development [49]	Sabeen Tahir	and reduces the cost of development for large-scale projects without spending too many resources			

Blockchain Platforms are listed in Table 2.10. In this table the advantages and lacking of blockchain platform are listed. These platforms help to implement framework for requirement negotiation. The blockchain platforms are very effective and secure to use. These platforms are adopted in different fields. These platforms are decentralized and effective and can help to speed up the process of requirement negotiation process.

Table 2. 10: Bibliomatric Analysis of Blockchain Platform

Paper #	Title	Author	Key Factors	Advantages	Limitations	Year
1.	A High Performance Blockchain Platform for Intelligent Devices [14]	Yu, Shitang, Lv, Kun Shao, Zhou, Guo, Yingcheng, Zou, Jun, Zhang, Bo	Design a high performance blockchain platform, using technologies	Efficient connection, provides higher consensus efficiency while guarantee the decentralization, provide higher efficiency	Repetitions in model, Not secure, Complex	2019
2.	A High Performance Blockchain Platform for Intelligent Devices [54]	Shitang Yu, Kun Lv, Zhou Shao, Yingcheng Guo, Jun Zou, Bo Zhang	Design a high performance blockchain platform, using technologies such as distributed network architecture, intelligent devices node mapping, and PBFT-DPOC consensus algorithm	Provides higher consensus efficiency while guarantee the decentralization, efficient connection of intelligent devices	Security is missing	2018
3.	Air Gapped Wallet	Amanda Davenport,	Using air gapped wallet	Most secure implementation	Wallet analysis and	2019

	Schemes and Private Key Leakage in Permissioned Blockchain Platforms [74]	Sachin Shetty	techniques	possible, provide an upper bound on wallet security, can help user identify the weakest parts of their air gapped wallet scheme	quantification,	
4.	CoDAG: An efficient and compacted DAG-based blockchain protocol [72]	Shu Yang, Ziteng Chen, Laizhong Cui1, Mingwei Xu, Zhongxing Ming, Ke Xu	Propose a compacted DAG-based blockchain protocol CoDAG that greatly improves the throughput and performance of blockchain	Improve the linear structure of traditional blockchain protocol	Tune the parameters for better performance; combine with hybrid consensus to improve the throughput further.	2019
5.	Hybrid Blockchain Design for Privacy Preserving Crowdsourcing Platform [45]	Saide Zhu, Huafu Hu, Yingshu Li, Wei Li	Propose a novel hybrid blockchain crowdsourcing platform to achieve decentralization and privacy preservation	Ensure secure communication between there users and the workers, decentralization and privacy preservation	Test the performance of the public chain as well as the interaction between the public chain and the subchains	2019
6.	ScalablePrivacy-Preserving QueryProcessingOverEthereumBlockchain [59]	Shlomi Linoy, Hassan Mahdikhani, Suprio Ray, Rongxing Lu, Natalia Stakhanova, Ali Ghorbani	Proposed system uses big data processing techniques	Provides a secure, robust, and scalable way to process SQL queries over any blockchain	Time delays	2019

The applications in which blockchain is used are studied and addressed in Table 2.11. These blockchain based applications and blockchain methods help to give a better understanding of blockchain and help to develop a framework using features of blockchain. Blockchain based applications are more secure and efficient than other applications. Blockchain based applications helps to develop framework for requirement negotiation process.

Table 2. 11: Bibliomatric Analysis of Blockchain Applications

Paper #	Title	Author	Key Factors	Advantages	Limitations	Year
1.	Block chain based secure scheme for mobile communication [16]	Chen, Liu Fei, Li, Yu Shan Wen, Hong Lei, Wen Xin Hou, Wen Jing Chen, Jie	Proposed a blockchain for mobile communication	Secure communication	Techniques discussed are time consuming, not secure	2018
2.	BlockchainCurrentAchievements and Future Prospects Challenges-CombiningAIBCs [80]	Prof. Kevin Werbach Spyros Makridakis, Antonis Polemitis, George Giaglis, Soula Louca	Discussing blockchain achievements and future work	Helps to find future work in blockchain	Other elicitation techniques can also be used, requirement validation is not used	2018
3.	Exploration of Block chain Technology in Electric Power transaction [20]	Haining, Wang, Chunyan, Wang, Haoyue, Zhao, Peiyu, Xi, Qian, Zhang	Combining the transaction link of energy Internet with block chain technology	Can effectively solve the transaction Friction, maintain the order of the market and guarantee the legitimacy of the transaction	Not covering all the application areas	2019
4.	A security authentication scheme of 5G ultra-dense network based on block chain [44]	Chen, Zhonglin Chen, Shanzhi Xu, Hui Hu, Bo	The principle of fast authentication with APG-PBFT algorithm is present in this paper	Can reduce the authentication frequency	Not prioritize efficiently, Time consuming	2018
5.	Some Simple Economics of the Blockchain [60]	Catalini, Christian, Gans, Joshua S.	Identify cost of verification and networking	Gives an overview of cost factors of blockchaim	Repetitions in model, Not secure, Complex	2016
6.	Building Secure Infrastructure for Cloud Computing Using Blockchain [65]	Sharma, Shweta Gaur Ahuja, Laxmi Goyal, D. P.	Presents Blockchain and compare the various platforms on which blockchain can be implemented	Illustrates the use of Blockchain applications for building secure infrastructure of cloud computing	Techniques discussed are Time consuming, Not secure	2019

7.	Summary for Policymakers [66]	Brito, J Castillo, Andrea	Introduction and explanation of bitcoin, Brito and Castillo both support innovation, clarity	Helps to understand the process of bitcoin and digital trading using bitcoin	Other elicitation techniques can also be used, requirement validation is not used	2013
8.	Application of block chain in multi-level demand response reliable mechanism [67]	Cui, Gaoying Shi, Kun Qin, Yuchen Liu, Lin Qi, Bing Li, Bin	Private block chain is chosen to solve the problem of mutual trust between users, load aggregators and power grids in multi-level demand response reliable communication	Demand response automation problem will be solved easily	Not covering all the application areas	2017
9.	Research on Life Cycle of Power Financial Products based on Block Chain Technology [69]	Junfeng Shi , Qinghua Zhu, Niqin Jing, The Nakasumi, Mitsuaki	New Life Cycle model of Power Internet Financial Products was proposed under the Block Chain effects	Helps to improve the quality of software projects	Not for large projects, Not synchronized Time consuming	2017
10.	How to Time-Stamp a Digital Document [73]	Haber Stuart W. Scott, Stornetta	Propose computationally practical procedures for digital time-stamping	Infeasible for a user either to back-date or to forward date his document, even with the collusion of a time-stamping service	Not synchronized, Techniques can't be applied to all expert systems. Requirement not defined properly	1991
11.	Blockchain Current achievements and future prospects Challenges combining aibc [10]	Prof. Kevin Werbach, Spyros Makridakis, Antonis Polemitis, George Giaglis, Soula Louca	Identification of future prospects challenges in blockchain technology	Helps to improve quality of blockchain based frameworks	Not identifying all the future prospects	2017
12.	A Hybrid Blockchain Architecture for Privacy-Enabled and Accountable	Harsh Desai, Murat Kantarcioglu, Lalana Kagal	Propose a novel hybrid blockchain architecture that combines private and	Only the auctioneer can learn the bids, and no one else, efficient in terms of run time and monetary	Create a framework for multiple blockchains hosting different	2019

	Auctions [53]		public blockchain to allow sensitive bids to be opened on a private blockchain	cost	applications and show how we can better preserve privacy when private, public and consortium blockchains are combined	
13.	A Privacy-Aware PKI SystemBasedon Permissioned Blockchains [62]	Rong Wang, Juan He, Can Liu, Qi Li, Wei Tek Tsai, Enyan Deng	Proposes a privacy-aware PKI system based on permission BCs	The separation of user registration and authorization, and has the characteristics of anonymity and conditional traceability, so as to realize to protect user's identity privacy	Security can be further improved	2018
14.	A Privacy-Preserving Voting Protocol on Blockchain [55]	Wenbin Zhang, Sheng Huang, Yuan Yuan, Yanyan Hu, Shaohua Huang, Shengjiao Cao, Anuj Chopra	Propose a native blockchain voting protocol for peers to vote over their existing blockchain network without the need of any trusted or third party	Facilitate decision-making in a decentralized and secure manner, end-to-end privacy and possesses desirable properties such as detect ability and correct ability against cheating.	Need to perform formal security analysis, Potential security attacks, like cartel attack should be tested against the design	2018
15.	A Reputation Management Framework for Knowledge-Based and Probabilistic Blockchains [64]	Tara Salman, Raj Jain, Lav Gupta	Framework is applied to malicious node detection where malicious agents are excluded from blockchain consensus.	Detecting and excluding malicious nodes	Can use for consensus calculation, where agent contribution depends on their prior performances.	2019
16.	Access Control for Electronic Health Records with Hybrid Blockchain-Edge Architecture [68]	Hao Guo, Wanxin Li, Mark Nejad, Chien-Chung Shen	Propose a hybrid architecture of using both blockchain and edge nodes to impose attribute-based access control of EHR data	To execute smart contracts so as to impose ACL policy and, to record legitimate access events into blockchain	Investigate novel consensus protocol designs for the proposed mechanism to achieve better performance	2019
17.	Blockchain Dividing Based	Suisheng Li, Hong	Construct a trust	Can make statistical analysis of	Can be further improved	2019

	on Node Community Clusteringin Intelligent Manufacturing CPS [71]	Xiao, Hao Wang, Tao Wang , Jingwei Qiao, Shaofeng Liu	relationship model according to the equipment communication characteristics of intelligent manufacturing CPS system	communication data in the system, improve the concurrency of the system		
18.	Blochchain-based Real Estate market: one method for applying Blockchain technology in Commercial Real Estate Market [15]	Sobhan Latifi, Yunpeng Zhang, Liang-Chieh Cheng,	Using employment of blockchain in RE market and represent the facilities it can give to the RE market	Offer meaningful tools for a game theoretic stable-priced market, process integrity, network reliability and longevity, faster transactions and lower transaction costs	Architecture proposed can be more flexible and simpler	2019
19.	ChainSplitter: Towards Blockchain-based Industrial IoT Architecture for Supporting Hierarchical Storage [58]	Gang Wang, Zhijie Jerry Shi, Mark Nixon, Song Han	Proposed a hierarchical storage structure to store the majority of the blockchain in clouds, and maintain the most recently generated blocks in a blockchain overlay network	Maintain both blocks and transactions generated by the iot networks	Work on the implementation of the proposed blockchain-based iot architecture in more real iot applications	2019
20.	Effective scheme against 51% Attack on Proof-of-Work Blockchain with History Weighted Information [70]	Xinle Yang, Yang Chen and Xiaohu Chen	Proposed an approach to increase the cost of a successful 51% double-spending attack on Proof-of-Work types of Blockchain protocols	Utilizes the frequency rate of miners in history blocks and calculates the total Historical Weighted Difficulty to determine if branch switch is needed, can improve smaller blockchain security drastically with easy integration	Only applicable on ethereum	2019
21.	Evaluating The Impact of Network Latency on The Safety of Blockchain	Luming Wan, David Eyers, Haibo Zhang	Investigate the impact of a wide range of network latency configuration on	Quantify blockchain security	Time spent	2019

	Transactions [61]		blockchain security			
22.	Fast chain: Scaling blockchain system with informed neighbor selection [57]	Ke Wang, Hyong S. Kim	Propose Fast chain to scale the effective block rate of blockchain systems	Reduces the block propagation time through its informed neighbor selection policy, effective when nodes have different mining powers	Time can be reduce by more effective techniques	2019
23.	Traceability in Permissioned Blockchain [18]	Tatsuo Mitani, Akria Otsuka	Proposed the scheme that the transactions and their history in the permissioned blockchain can be verified and concealed from the permission less blockchain	Transactions and their history in a permissioned blockchain can be verified and concealed from a permission less blockchain	Time consuming	2019
24.	TrustChain: Trust Management in Blockchain and IoT supported Supply Chains [19]	Sidra Malik, Volkan Dedeoglu, SalilS. Kanhere , Raja Jurdak	Proposed a trust management framework for blockchain based supply chain applications	Address the issue of trust associated with the quality of commodities and the entities logging data on the blockchain	Different network models will affect the average throughput and latency of the system	2019

Related studies that help in gathering and supporting information are in Table 2.7, 2.8, 2.9, 2.10 and 2.11 which show the advantages, limitation, and key factors that are identified in related studies. Literature in above Table 2.8 shows is related to the factors of requirement negotiation and its limitations, also about the platforms, applications, framework and strengths, weaknesses of blockchain technology. The limitations in requirement negotiation process helped to find out the main factors to focus in this research area and can be improved using blockchain based framework.

Many research papers are studied thoroughly about requirement negotiation and blockchain technology. Few papers discussed factors in requirement negotiation process. Some papers show the gaps in requirement negotiation process and some papers help to find the improvements in requirement negotiation process. A list of factors of requirement negotiation is identified which needs further improvement. The factors will be validated through survey in which questions about factors will asked from respondents.

There is a need of improvement in factors of requirement negotiation process, so we have identified that these factors can be improve using blockchain based technology. Many papers which are listed in Table 2.7are about blockchain technology in which different features, platforms and applications of blockchain technology are briefly explained. Types and platforms of blockchain technology are also explained which helps to introduce a framework for the improvement of requirement negotiation process factors. The introduced framework will be based on the decentralized feature of blockchain technology and it will be more efficient and easy to use. The introduced framework will be validated using survey by taking the responses of experts in blockchain and requirement negotiation fields.

Blockchain technology will be very helpful in the requirement negotiation process. Not only it will help developers to gather requirements from user but also help research students and researchers to gather validated and prioritized requirements. Further it will help society because well prioritized, managed and quality requirements will help to develop quality products which will be improved, easy, efficient and reliable for the users and will help society in fulfilling their tasks in an easy way.

2.5. Discussion

In systematic literature review the factors of requirement negotiation process are identified by reviewing many research papers and the framework of blockchain, its weakness

and strengths are studied thoroughly. A systematic literature review helped to gather data from most relevant and important research papers. After the identification of gaps in requirement negotiation process a solution is identified by doing research in blockchain technology and a framework is introduced for requirement negotiation, elicitation, validation, prioritization and negotiation. A bibliographic analysis is shown in Table2.7 which shows the limitations of research papers which are studied for doing research. These limitations help to find a solution. As after doing research in blockchain technology many papers helps to develop a framework using decentralized feature of blockchain technology in requirement negotiation process. Blockchain is a decentralized, secured and distributed ledger technology which provides an immutable record of your transactions. Blockchain is a decentralized online global database so its ledger is shared among all computers. Through internet all the transactions are recorded in computer and this ledger is shared by every computer around the world and anyone can access these transactions and add transactions but cannot change the ledger after transaction is added.

Blockchain is most widely used and spread in every field and it makes the work of many fields easy and reliable with its efficient features. This innovative technology can now be used to improve the factors of requirement negotiation process.

2.6.   Summary

To improve the processing, quality and sustainability of requirement negotiation process all of its factors can be improved by using some innovative technology. A there is always a need of improvement with latest innovations and inventions, blockchain oriented requirement engineering is discussed to make requirement negotiation processes more verified, validated and easy to apply. Blockchain is a collection of data and by connecting one block after another in a chronological way each piece of data is added to blockchain. This series of chronologically connected blocks make a chain of blocks and it is called blockchain [35].

As we know that the idea of blockchain innovation is spreading widely, because the concept can now be applied to any requirement for trustworthy record. It facilitates people's record with encryption and make them secure and synchronized [36]. Blockchain is allowing people to secure digital relationships that were impossible before because data is being

disclosed, recorded and secured differently. So the uniqueness of blockchain is that it is secure, immutable and less costly [37]. By using blockchain platform in requirement negotiation we can create requirement engineering processes more secure and accessible and it can help gathering and validating requirements easily. The blockchain technology integrates a series of technical systems with the following characteristics of decentralization, openness, autonomy, anonymity, secured and information that cannot be tempered.

As we have discussed before that the quality of project is because of well gathered, complete and negotiated requirements. These are difficult and time consuming processes. So to improve the quality of softwares the requirements must be negotiated accurately and completely by latest technology. For this purpose we can use blockchain platforms to make requirement negotiation process more efficient.

Innovation of Blockchain is a revolution in frameworks of record [38]. Thus blockchain technology is adopted in many organizations and application because of it the quality, security and speed of projects improved. So to improve the quality and speed of requirement negotiation process and to reduce the failure rate of projects blockchain oriented requirement negotiation is discussed to make requirement engineering processes more verified and easy [39]. Some applications of blockchain as a record are digital identity and tokenization [40]. Blockchain is the grouping of assortment of advancements of the products. Cryptography, computer network and mathematics etc are used to create blockchain technology.

The objective of Blockchain is to make a decentralized advanced framework by using algorithms and cryptography which makes it secure. The use of blockchain is broad and applicable in all parts of society [41]. Platforms based on blockchain will help people to gather information according to its type. If the record is from public blockchain than user can read write or edit information and if it is from private blockchain than any individual or an organization is in charge who checks and secure important things such as read or write or whom to give access selectively. It works like a private property of anyone. If information is from Consortium or Federated Blockchain than rather than one in control, you have more than one in control. In consortium blockchain a group of organization's agent people settling on choices together for benefit of whole system [42].

To improve the quality of projects the requirements must be gathered and negotiated accurately and completely. For this purpose we can use blockchain platforms to make requirement negotiation process more efficient. In the context of requirement engineering blockchain can maintain a sequence of records, researches, authorized information, transactions, negotiations and other supporting activities and organizations. Blockchain can improve the functionality of requirement negotiation processes which in result will increase the rate of successful projects [43]. So by using blockchain platform in requirement negotiation we can create requirement engineering processes more reliable and accessible and it can help gathering requirements more synchronized, correct, easy and the people from any place can easily gather authorized requirements more easily which will reduce their time and efforts. So the aim of our research is to introduce blockchain oriented requirement negotiation framework to make requirement negotiation process more efficient. The main objective of our research is to introduce the emerging technology (blockchain) oriented framework for requirement negotiation to make it more automated, effective, easy and efficient. So this research has identified factors for improvement in requirement negotiation process using blockchain technology to make requirement negotiation process efficient.

CHAPTER 3

Methodology

Previous chapter identified from literature the factors in requirement negotiations process and features of blockchain technology which can improve these factors. In this section methods are explained which are used to do research how the research has done, type of research, how the data is collected, how data is analyzed and what tools and materials were used, to evaluate the validity and reliability of research.

3.1. Introduction

A summary on research methods and ways to apply these research methods and their validation is given in this chapter. This chapter explains the methods used in research. These methods are systematic literature review, quantitative study, how the framework is developed and a mixed method research that describes the qualitative study and focus group study for framework validation. This chapter describes that how the methods are applied and how these methods are validated in following section.

3.2. Research Strategy

A paradigm is a basic belief system and a way how we understand the reality and study it theoretically with assumptions and identify the relationship among theory and data. In literature review there are four general categories of paradigm these are pragmatism, constructivism, participatory and post positivism. To deal with objective discussed in chapter one research paradigms are followed in this research [45].

Systematic literature review is a systematic way of searching for studies, defining the research questions and assessing the findings. The findings are asses qualitatively or quantitatively and research questions are defined after a systematic review and by studying and understanding the previous literature with limitations. The main purpose of SLR is to combine all the existing study on research questions as well as support the development of framework and evidence based guidelines.

In SLR thoroughly studied the process of requirement negotiation and blockchain based frameworks by using qualitative study method [46]. The challenges are than validated through a quantitative study which helped to identify that how many challenges are there in requirement negotiation and blockchain which can be improved through a framework development [47]. A mixed method research is conducted for further validation of that introduced blockchain based framework for requirement negotiation.

3.2.1. **Quantitative Research**

In quantitative research data is investigated systematically and empirically with mathematical calculations and computational techniques. Data is gathered and evaluated through quantitative research methods which are survey, card sorting. We are using survey method to validate the findings of study. This method gives numerical evaluation of outcome of study by distributing questions in all the sampled population.

3.2.2. **Qualitative Research**

In qualitative research non numerical data is gathered in to get meaningful information about the findings. In this type of research data is gathered and validated by some non numerical methods which includes interview, semi structured method, case study, introspection or focus group methods. We are using focus group method to gather meaningful information for further verification and validation of data.

3.2.3. **Mixed Method Research**

More than one method is used to identify, and validate the findings in single study to validate the challenges in requirement negotiation and blockchain based technology. Mixed method research (Methodological Triangulation) is used to ensure that the findings are recent and verified. Therefore, it is possible to find and remove the disagreements until they spread throughout the study [48]. There are two types of mixed method research and there across method is used for triangulation. In across method both qualitative and quantitative data collection techniques are used.

After a systematic literature review is conducted to study the process and challenges of requirement negotiation and to study the uses, framework and platforms of blockchain

technology. To validate these challenges and findings of study quantitative method is used in which a survey is conducted by the help of questionnaires in targeted audience.

For further verification and validate of findings of study a qualitative method is used which includes focused group method. Qualitative study validates the findings of quantitative study. Thus as compared to quantitative study, qualitative study holds more value. So mixed method is conducted for verification and validation and it decreases the weaknesses of single method and increases the efficiency and validation of results [49].

In mixed method data is collected, analyzed, combine the findings, increase validity and creates a justified conclusion through both quantitative and qualitative methods.
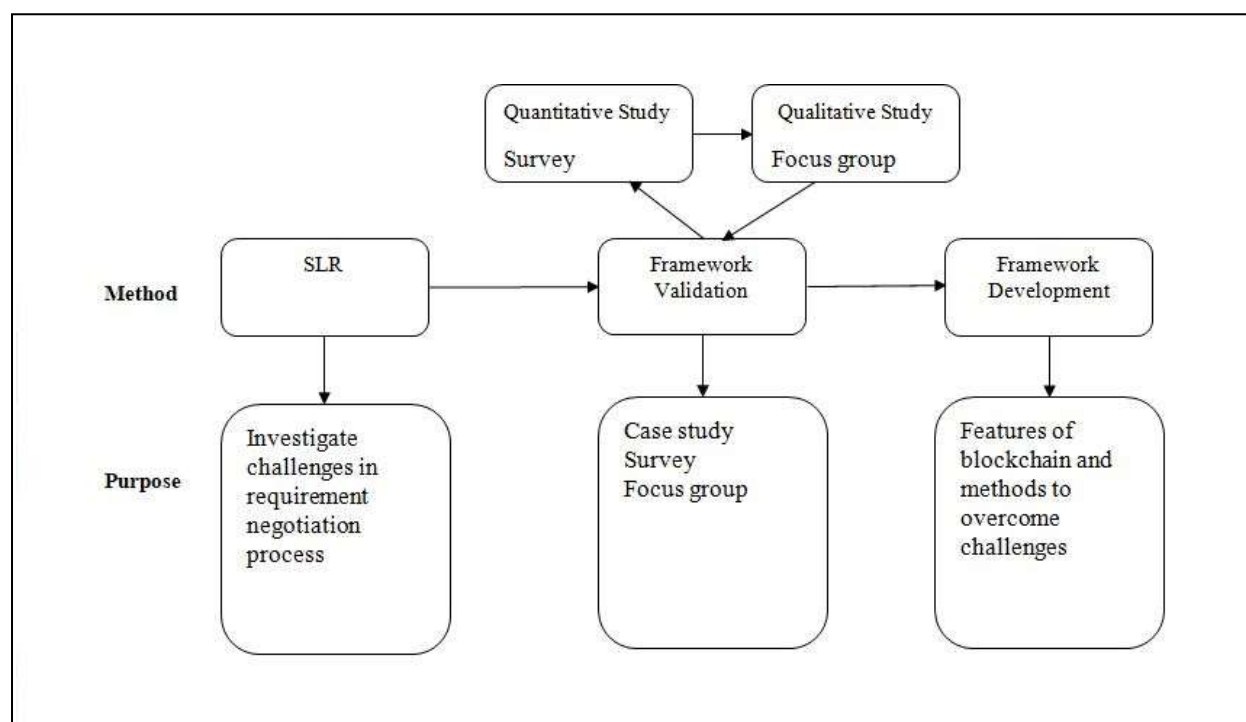

Figure 3. 1: Methodology used in study

The methodologies used in this research are shown in Figure 3.1 which shows that too identify factors in requirement negotiation process and to study the framework or blockchain technology a systematic literature review is conducted. After the factors are identified the validation of these factors is mandatory step so a quantitative study is done for evaluation of factors. To improve those identified factors of requirement negotiation process the framework is developed. For validation of the framework developed qualitative study is done which is

focus group meeting which helped to further justify the quality reliability and validity of research.
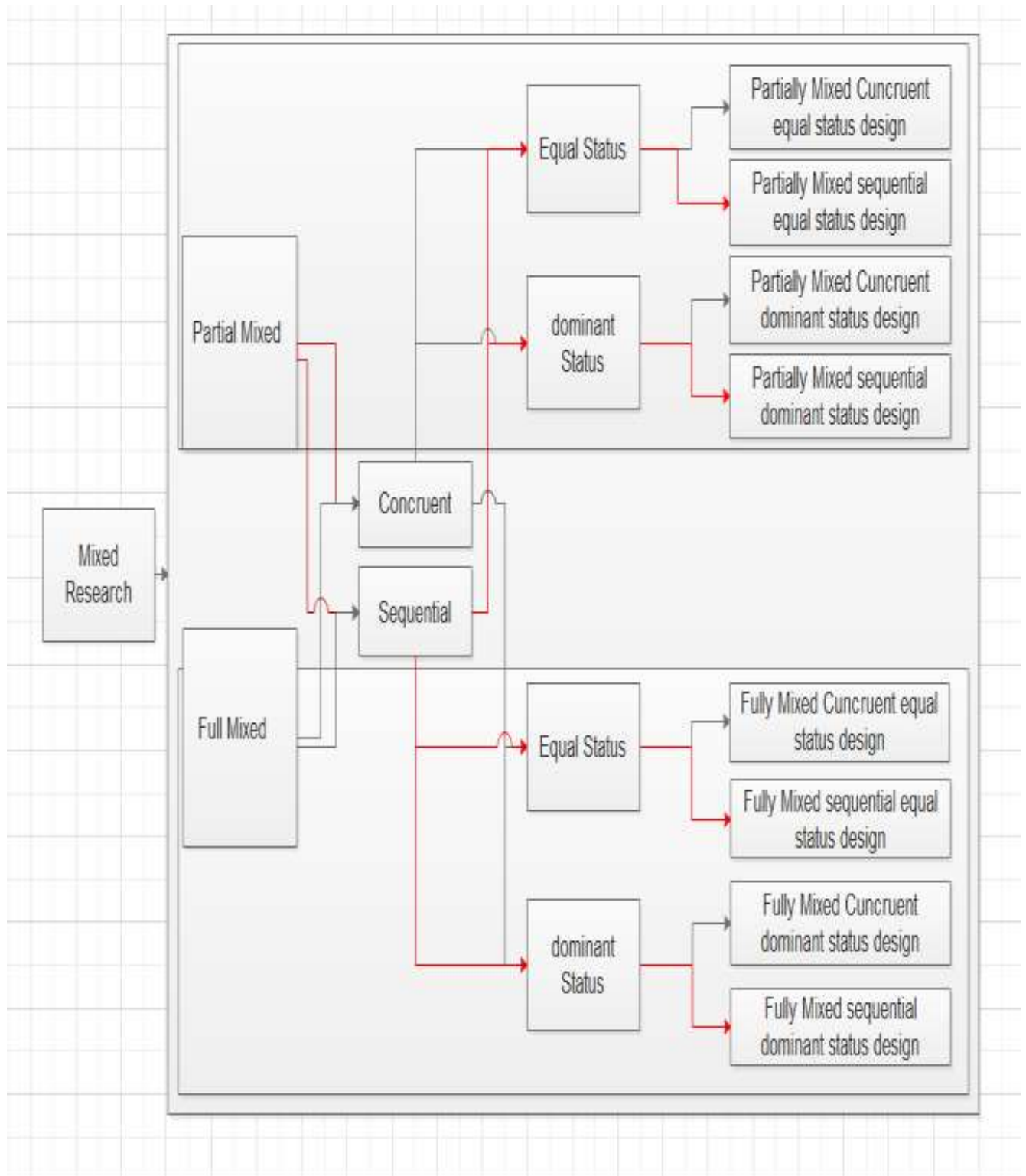

Figure 3. 2: Mixed method research dimensions

By using full mixed method research a sequential process is used. In sequential full mixed method a dominant status design is used to identify and justify the findings of study. Information is identified in details by using some methods and then another method is used to support that information. It confirms that whether the information gathered is supporting the research or not. Final result will be evaluated after conducting mixed method research.
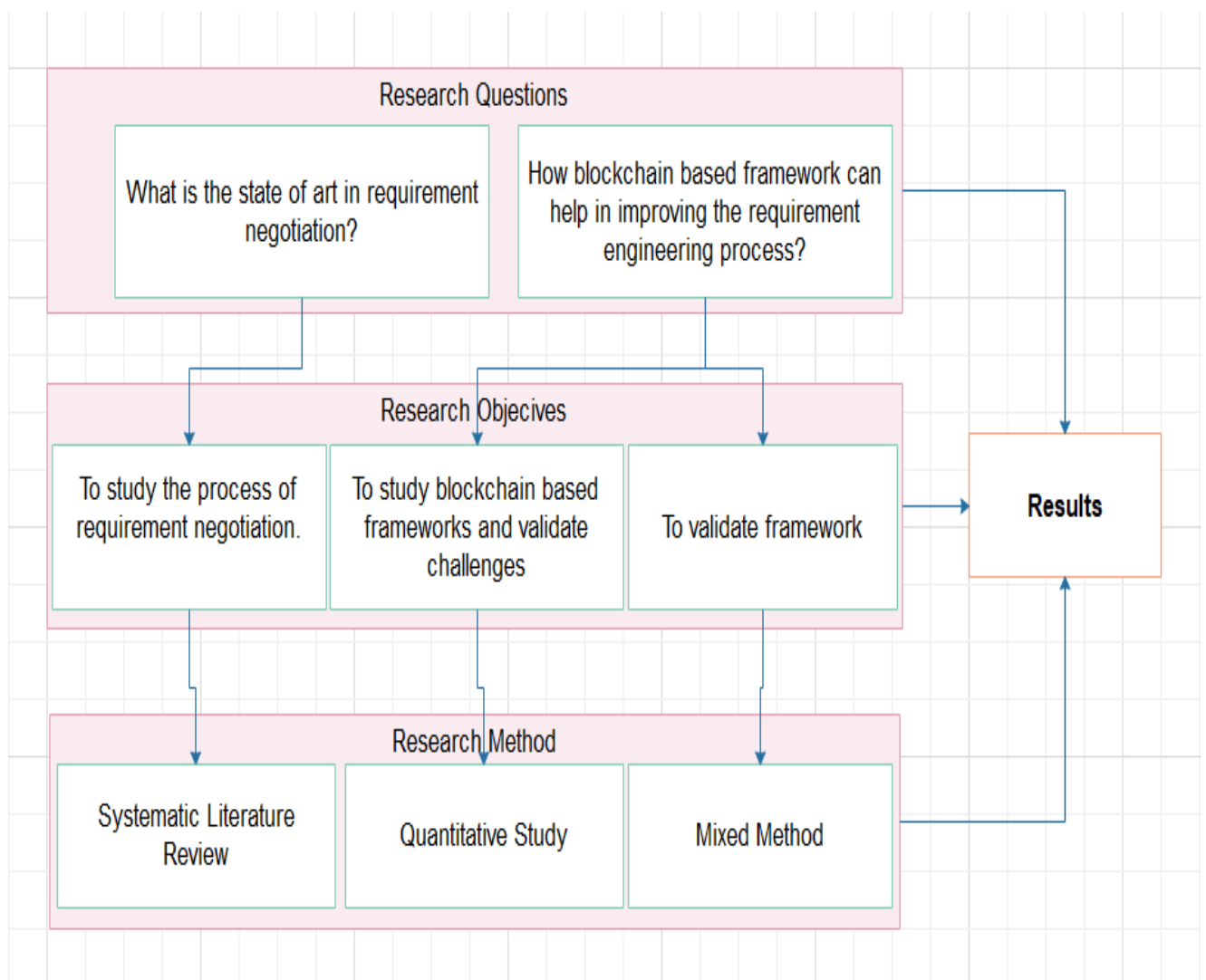

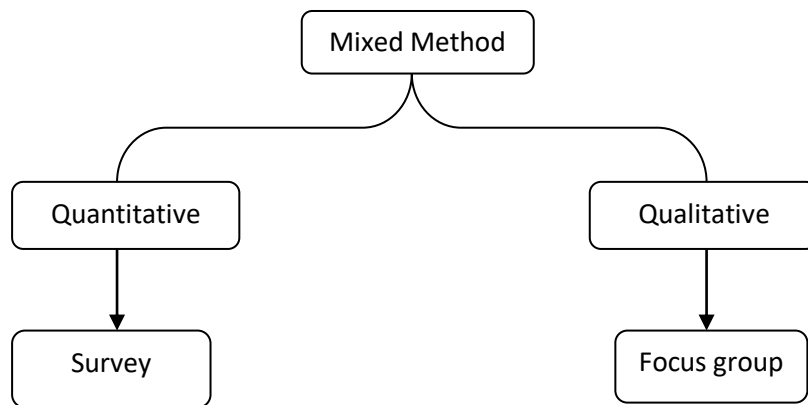Figure 3. 3: A procedural view of methodology

Figure 3. 4: An overview of methodology

3.3. **Research Context and Justification**

In context of software project development the purpose of conducting this research is to find and validate the challenges of requirement negotiation and to purpose the solution using an innovative technology. By literature review and analysis blockchain based framework is developed to identify and validate the requirements and to create successful projects. The framework will validate the requirements under budget and time and help to create successful projects.

In this research we have focused on framework development by analyzing the requirement elicitation and validation process. Previous chapters of this research focused on the challenges in requirement elicitation, validation and negotiation and focused on how blockchain technologies can improvement the process of requirement negotiation. In this chapter and in the proceeding chapters the development of framework is discussed which will improve the process of requirement negotiation to create successful projects. The justification for undertaking this research is based on the fact that there is a range of limitations in present requirement negotiation process which are mentioned in previous chapters. The purpose of this study is to introduce and develop a blockchain oriented framework that is more efficient and easy to use and improve the project quality, increase the success rate of projects, complete projects in estimated budget and time.
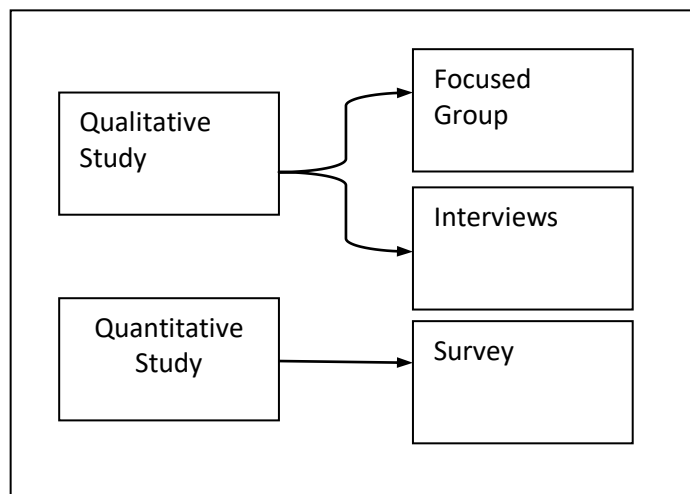
Figure 3. 5: Mixed Method using in this research

In this research survey is conducted to gather quantitative information for validation of framework and research objectives. To identify, verify and validate the research questions in a detailed manner a qualitative study is done using focused group and interview.

3.4. **Methods and Respondent's Profiles**

The implementation of methods survey and focused group are discussed here and profiles of respondent are provided in this section.

3.4.1. **Survey**

To gain information and insights of data a survey is used which collects data from targeted groups of respondents. Depending on the methodology used in research there are many ways to perform survey. Survey method studies the sampling from a huge population and use different techniques to collect data, in this research questionnaire is constructed to improve the number of accuracy of responses to survey. Number of questions is asked in survey that may or may not be answered. To prove that none of the question in questionnaire is giving biased opinion due to which outcome will influence the results of research a standardized procedure is used. Though by asking questions on paper questionnaire is conducted and with the advancement in technology the process of distribution of questionnaire is commonly done by using digital media like email, urls, linkedin, social networks [50]. A questionnaire is distributed among all the sampled population through digital mediums and they answered all the questions.
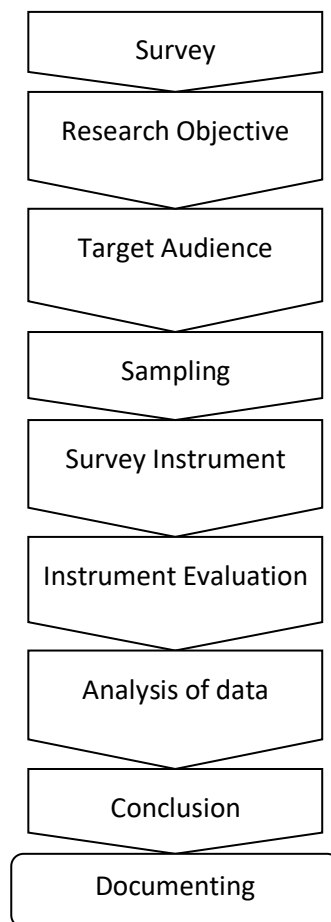
Figure 3. 6 Survey design guidelines

3.4.1.1. **Research Objective**

The main focus of this research is to develop a framework using blockchain technology in requirement negotiation process. So the survey is conducted to answer the research question and the main objective of survey is to answer all the relevant question of research. The objectives of survey are:

- The target audience should be from relevant field.
- Target audience should be experienced or expert.
- Answer other possible direction of research.
- Find the resources which will be easy to accomplish the survey goals.

3.4.1.2. **Top-down approach/ bottom up approach**

A top down approach is used which first defined goals followed by more detailed questions. Then these questions are further divided into sub component to form the survey questions. The main research questions which are going to be answered after survey are:

RQ1: What is the state of art in requirement negotiation?

RQ2: How blockchain based framework can help in improving the requirement negotiation process?

These questions will be further divided into sub parts each question will cover any component of RQ1 or RQ2.

3.4.1.3. Sample Size

A probabilistic sampling is used in survey to select the unit which must have equal probability for selection. The target audience for this survey must be relevant to the field and experts and they cover the below characteristics.

- Size

- Job and responsibilities

- Relevant experience

- Education level

- Domain knowledge about survey

The size of target audience is more than 200; the total sample size is 230. Sample is experienced in software engineering and blockchain field. Some are experts in software engineering field and some are blockchain experts. Sample has experience in relevant field. Sample is well education all of them are Post doctorate (PHD). Sample has in depth knowledge about software engineering and blockchain technology and survey.

3.4.1.4. Respondent's profile for survey

To get significant and accurate responses from respondents, a survey is conducted among experienced individuals. The survey was sent to different software houses and research groups having experience in blockchain based technology. Responds were shortlisted on the bases of the experiences of respondents. Then these responses were entered in SPSS statistics software for analysis of data.

3.4.1.5. Survey Medium

Medium used for survey are personal interaction, by phone call, linkedin, and by email.
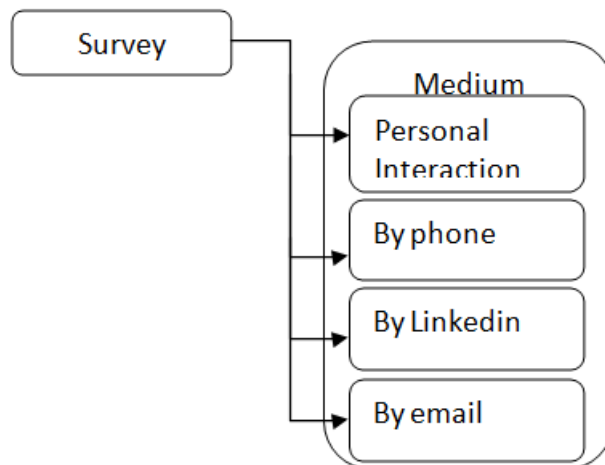
Figure 3. 7 Survey Medium

3.4.1.6. Survey Instrument (Questionnaire)

Questionnaire is the main instrument which is used to get responses from respondents. For designing a questionnaire internal questions are developed from main research questions or objectives, goals of research. The internal questions are developed from main research question or objectives of thesis. Survey results only depend on the questionnaire and in this research self administrated questionnaire is designed. Self administrated questionnaire are filled by the respondents in the absence of member of research team. The questionnaire consists of 19 survey questions which answers the main objectives of research.

3.4.1.7. Survey Questions

Survey questions are generated according to the research objectives and they are supporting the research objectives. Survey questions are well prioritized according to the research objectives. First questions are about requirement negotiation and its factors and the last questions are for improvement of requirement negotiation using blockchain. The length of questionnaire is 3 pages.

3.4.1.8. Response format

The data is collected in the form of likert scale. Likert scale is used to get the responses which are easy to evaluate after cleaning of data. A questionnaire is added in Appendix A.

1. Do weak algorithms in requirement negotiation produces low quality software projects?
2. There are many algorithms but still conflicts between stakeholders make decision making complex.
3. Requirement negotiation process lacks the quality communication.
4. Requirement negotiation in crowds sourcing is time consuming.
5. Requirements are less synchronized.
6. Requirement negotiation through social media mostly leads to gather unauthorized data.
7. Requirement negotiation is complex process.
8. Requirement negotiation is time consuming process.
9. It is necessary to validate the requirements through an efficient technology.
10. It is necessary to validate the requirements through an efficient technology.
11. Blockchain can solve the conflicts between stakeholders because of its effective frameworks.
12. Blockchain can improve requirement negotiation through crowd sourcing.
13. Blockchain can improve requirement negotiation through crowd sourcing.
14. Can blockchain based framework gather synchronized requirements?
15. Do blockchain help to gather authorized data from social media?
16. Can requirement negotiation process be improved by blockchain?
17. Do blockchain help to reduce time consumption during requirement negotiation process?
18. Can blockchain based technology improves the speed of requirement negotiation process?
19. Can blockchain based platform easily be implemented in requirement negotiation?

3.4.1.9. **Justification for Survey**

To uncover the correct answers of varied question of topic survey was conducted. By conducting right answers from a large amount of population survey is the right way. There is no work done in requirement negotiation process using blockchain based framework so it is vital to take answers from large number of experts. So survey helped gather responses from large amount of experts the data will give correct results. 230 respondents were selected for survey from all around the world who are experts from software engineering and blockchain. Their responses gave the correct results to further evaluate and validate the results focus group meeting was conducted in which all the factors were discussed.

3.4.2. **Focused Group**

To gather and validate data a group of expert people is selected who participate in facilitated discussion intended to elicit perceptions. Online focused group generates results quickly and are easy to conduct, are less costly than other methods. In this method information is gathered in respondents own words which helps to write the accurate information. Focused group method is conducted in comfortable and receptive environment.

3.4.2.1. **Respondent's profile for focused group**

To get significant and accurate responses from respondents, a survey is conducted among experienced individuals. The focus group meeting invitation was sent to different software houses and research groups having experience in blockchain based technology. Respondents were shortlisted on the bases of the experiences. Total of 7 members attended focus group meeting and gave their responses. Then these responses were entered in SPSS statistics software for cleaning and analysis of data.

3.4.2.2. **Sample Size Focus group**

Total of 7 members attended focus group meeting and gave their responses. These members were experts and experienced in software engineering and blockchain fields. These experts discussed all the questions and give their reviews in a comfortable environment. It was an online meeting in which all the members were online at same time and gave their valuable reviews according to their experiences. The application used for online meeting was Zoom and the data was noted down on a paper and meeting was also recorded to cover all the responses correctively. After that all the data gathered from respondents was added in SPSS and cleaned that data. The data was further evaluated and its Weightage values were generated. These Weightage values were than compared with survey to get final more justified answers.

3.4.2.3. **Focus Group Questions**

1. Do weak algorithms in requirement negotiation produces low quality software projects?
2. There are many algorithms but still conflicts between stakeholders make decision making complex.
3. Requirement negotiation process lacks the quality communication.

4. Requirement negotiation in crowds sourcing is time consuming.

5. Requirements are less synchronized.

6. Requirement negotiation through social media mostly leads to gather unauthorized data.

7. Requirement negotiation is complex process.

8. Requirement negotiation is time consuming process.

9. It is necessary to validate the requirements through an efficient technology.

10. It is necessary to validate the requirements through an efficient technology.

11. Blockchain can solve the conflicts between stakeholders because of its effective frameworks.

12. Blockchain can improve requirement negotiation through crowd sourcing.

13. Blockchain can improve requirement negotiation through crowd sourcing.

14. Can blockchain based framework gather synchronized requirements?

15. Do blockchain help to gather authorized data from social media?

16. Can requirement negotiation process be improved by blockchain?

17. Do blockchain help to reduce time consumption during requirement negotiation process?

18. Can blockchain based technology improves the speed of requirement negotiation process?

19. Can blockchain based platform easily be implemented in requirement negotiation?

3.4.2.4. **Qualitative Study**

In focused group members freely interact and influence each other during online discussion and selection of decision it takes up to 30 to 90 minutes. List of all the questions is distributed in members of focused group to obtain best responses. It is a best way to obtain detailed information about validation of framework.

In this research a focused group of 6 to 10 people is conducted to validate the blockchain based framework for requirement negotiation. These selected members study the paper thoroughly and give the best results. Members of focused group are selected on the bases of their history, experience and behavior and all the members typically don't know each other. Moderator takes noted of all the suggestions and responses from the members of focused group.

3.4.3. **Justification of focus group**

In focus group research 6 to 10 people are enough to provide feedback on the questions asked in a meeting. In interview based research respondent takes interviews from every interviewee one by one which is time and cost consuming, but in focused group research all of the interviewees are on same meeting at same time and they provide their feedback according to their expertise and experiences one by one. Because of single meeting it reduces time, cost and efforts which is better than interview based research in this section [51]. In focused group research the group interview is recorded and after the meeting it is easy to analyze the data of each interviewee. The focus group research is well organized research method which leads to the justification to research questions [52]. After using quantitative method (survey) for data analysis focused group method (qualitative method) is more suitable for validation of data. Focused group is used to discover the attitude, motivation and to reveal discourse of experienced people of requirement engineering and blockchain field [53]. In the presence of focused group all the questions are discussed in given time this discussions it more meaningful because the moderator creates a focused environment in which all the members of focused group share their opinions [54]. Focused group research confirms insights of data which is gathered through other methodologies. It is easy to organize than other methods [55]. Participants in focus group are volunteer they do not know each other and they are experts in field of requirement engineering and blockchain. Their opinions are more valuable and validate the data gathered through quantitative method [56].

3.5. **Verification and Validation of Framework**

It is important to verify and validate the findings to give suitability and acceptability to findings of research. Thorough study and expert review in specific area will validate the initial findings of study. For validation experts opinion is very vital and valuable. To validate the case study method the participation of experts is comprehensive. Expert review is most widely used phenomenon to validate and evaluate the worth of survey and results. Following are the validation frameworks of research methods.

3.6.   **Quantitative Validation**

Quantitative validation method observes the result and compares it with existing studies. Quantitative research creates the data which is ready for validation. Quantitative research finds the relationship between variables and result of research validates the type of relationship between variables and or whether there is a relationship between them or not. The results are verified by comparing with existing related studies. The quantitative study is validated and confirmed by expert opinion and interviews and then for further validation certain measurements are done.

3.7.   **Qualitative Validation**

By explanative, descriptive, practical and theoretical methods qualitative research can be validated. Descriptive validation is based on people and events in which findings of study are relevant to any information about specific people or individual or incidence, location or to observe the behaviour. Because this research is based on scientific paradigm so, descriptive research is not suitable method for qualitative validation in this research. For finding the facts and figures for understanding of researcher the interpretive research is used. The facts which are interpreted are the real responses of interviewers. For the confirmation correctness of in interpretation of researcher the transcript may be given back to interviewee. For observing that whether the findings of qualitative study are similar with contemporary study or not the theoretical validation is done. When the error rate in result of theoretical validation will be acceptable then the results of study will be accepted. To observe the similarity of results to the findings of other methods, concurrent validation is done on the findings simultaneously.

3.8.   **Objectives and Activities**

In the figure of procedural view of this research with respect to the type of study the process of meeting the objective and answering the research question is designed. Three objectives of this research are independent and answer the research questions which are raised in this research. To find the results from this process the outcomes are merged together. Research is started by identifying and studying the challenges of requirement negotiation to be presented for the survey. A systematic literature review method is done to briefly understand and describe the challenges in requirement negotiation process. When the opinion of experts is needed the qualitative method is used to verify the findings of research.

The qualitative method is done by conducting case study. Quantitative method is done to identify and validate the challenges in requirement negotiation process and to identify the blockchain based framework. Mixed method research is done for the validation of blockchain based framework which will improve the process of requirement negotiation. The qualitative and quantitative methods are used to evaluate that the studies is real and true in nature.
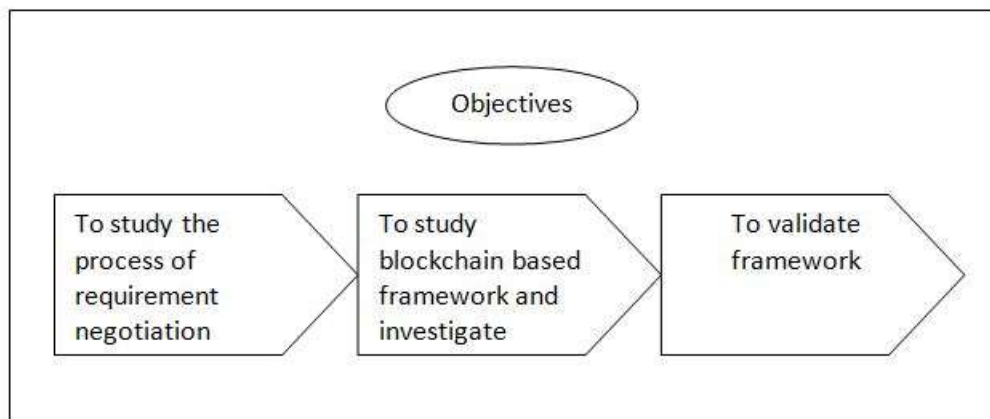
Figure 3. 8 Objectives of study

In this research study, interviews have been conducted to determine the association between the project factors and risk factors and on identifying the probabilities and impact of the risk factors. The interviews explain not only identified new findings but also confirms the existing findings, which is a characteristic of mixed method research. It can be concluded that the use of qualitative and quantitative methods is justified by the fact that the findings of the studies are concrete and less assumptive in nature. The model built on the findings performs reasonably well when tested against the inconsistent data sets.

3.9. **Summary**

In this chapter we have briefly discussed the methodology which we will conduct. In the start of chapter basics of research and research objective are describes and then presented a quick look on the research in software engineering.

Qualitative study, case study, quantitative study and focused group study are the research methods which have been discussed in detail. Secondary research designs are discussed in the research design. Quantitative research, qualitative research and mixed

method research is discussed in secondary research design. In this research the qualitative research is done through case study. For conducting case study its design and conduction strategies are briefly discussed in chapter. Focused group method is also done because it asks the participants for open end responses. By focused group method a quantitative method is implemented. For designing and conducting the focused group method a complete paradigm is briefly discussed. The process of calculation and evaluation and their sampling strategies is separately discussed in detail. The validation strategies for qualitative and quantitative research have been discussed and mixed method techniques have been briefly discussed.

Chapter 4

Data Collection

After conducting both survey and focus group their data was gathered correctively. In this chapter the gathered data from both methods will be analyzed and evaluated and then the differences between the results of both methods will be discussed in the last of the chapter. This chapter will show the final results and analyze the rate of all the factors according to respondents in a sequence. The data was gathered online and by visit from university. We visited 600 people and identified that how many of them are working in blockchain. Survey was sent to 570 people. Total 230 people respond to the survey.

4.1. Survey Results

Survey was done in a very systematic way survey design guidelines are used to conduct survey which helps to identify the right results. A questionnaire was designed which consist of all the 19 questions which supports the research. These questions are divided into two parts, half questions are about the gaps in factors of requirement negotiation process and other half questions are about the improvement of these factors using blockchain based framework. Survey was conducted from target audience of 230 respondents. These respondents were software engineering experts and blockchain experts. The respondents were accessed online using online mediums and in person also. After getting responses from the respondents the responses from the respondents were cleaned and analyzed in SPSS software. Cronbach alpha was found to check the accuracy of data. To check their Weightage values all these responses are further analyzed in table 4.1.A likert scale is used which is a systematic way of categorizing and analyzing the data. The values assigned to each data of survey are according to likert scale to find the accurate response of the respondents. The value assigned to each category is than analyzed by some specific algorithm to get desired results. To get their total value by multiplying them with Likert scale values (Strongly agreed responses will be multiplied with 2, agree response value will be multiplied with 1, neutral value will multiply with 0, disagree response value will be multiplied with -2 and strongly disagree value will be multiplied with -2) and then adding these multiplied values to get a total response value of each factor.

Table 4. 1 Results of responses from survey

No	Factors	Strongly Agree (2)	Agree (1)	Neutral (0)	Disagree (-1)	Strongly Disagree (-2)	Total (230)
1	Do weak algorithms in requirement negotiation produces low quality software projects?	67=134	116=116	34=0	12= -12	1=-2	236
2	Is it often complex to solve conflicts between stakeholders in requirement negotiation process?	67=134	114	36=0	11=-11	2=-4	233
3	How likely is it that lack of communication in requirement negotiation leads to produce low quality projects?	141= 282	63	18=0	6=-6	2=-4	335
4	Is requirement negotiation a time consuming process in crowd sourcing?	84=168	98	21=0	22=-22	5=-10	234
5	Do you agree that in requirement negotiation process requirements are less synchronized?	64=128	103	32=0	26=-26	5=-10	195
6	Do you agree with the fact that the data gathered through social media in requirement negotiation is unauthorized?	97=194	79	17=0	34=-34	3=-6	233
7	Do you agree that elicitation, validation and prioritization complex is core problem?	65=130	115	26=0	22=-22	2=-4	231
8	Does requirement negotiation process consume more time in requirement elicitation and validation?	69=138	122	15=0	19=-19	5=-10	246
9	Can the requirement negotiation process be improved by using some innovative technology?	89=178	107	27=0	7=-7	0=0	278
10	How likely blockchain can improve the quality of requirement negotiation?	67=134	117	30=0	13=-13	3=-6	232
11	Would Blockchain easily solve the conflicts between stakeholders?	77=154	92	26=0	29=-29	6=-12	205
12	Can blockchain improve communication gaps in requirement gathering?	82=164	106	14=0	21=-21	7=-14	235
13	Can blockchain improve requirement negotiation through crowd sourcing?	80=160	99	30=0	17=-17	4=-8	234
14	How likely blockchain improve synchronization between requirements?	69=138	111	24=0	21=-21	5=-10	218
15	How often blockchain help to gather authorized data from social media?	91=182	78	22=0	32=-32	7=-14	214
16	How likely requirement negotiation process be improved by blockchain?	78=156	107	22=0	20=-20	3=-6	237
17	How often blockchain reduce time during requirement negotiation?	84=168	94	29=0	17=-17	6=-12	233
18	Can blockchain improve the speed of requirement negotiation?	84=168	94	29=0	15=-15	8=-16	231
19	Can blockchain framework easily be implemented in requirement negotiation?	88=176	78	25=0	24=-24	15=-30	200

All these total values are the base to find Weightage value.

Results from Weightage Values

Weightage values shows the amount of accepted or rejected values the values above or equal to 0.95 will be accepted factors and all the factor values lower than 0.95 are the rejected factors. So to find this all the total values of responses of each factor in Table 4.1 will be divided by total number of responses which is 230. The result is shown in Table 4.2.

Table 4. 2 Accepted or rejected values

No	Factors	Weightage Values	Avg. Weightage Responses	Results
1	Do weak algorithms in requirement negotiation produces low quality software projects?	236	1.02608	Accepted
2	Is it often complex to solve conflicts between stakeholders in requirement negotiation process?	233	1.01304	Accepted
3	How likely is it that lack of communication in requirement negotiation leads to produce low quality projects?	335	1.45652	Accepted
4	Is requirement negotiation a time consuming process in crowd sourcing?	234	1.01391	Accepted
5	Do you agree that in requirement negotiation process requirements are less synchronized?	195	0.84782	Rejected
6	Do you agree with the fact that the data gathered through social media in requirement negotiation is unauthorized?	233	1.01304	Accepted
7	Do you agree that elicitation, validation and prioritization complex is core problem?	231	1.00434	Accepted
8	Does requirement negotiation process consume more time in requirement elicitation and validation?	246	1.06956	Accepted
9	Can the requirement negotiation process be improved by using some innovative technology?	278	1.20895	Accepted
10	How likely blockchain can improve the quality of requirement negotiation?	232	1.00869	Accepted
11	Would Blockchain easily solve the conflicts between stakeholders?	205	0.89130	Rejected
12	Can blockchain improve communication gaps in requirement gathering?	235	1.02173	Accepted
13	Can blockchain improve requirement negotiation through crowd sourcing?	234	1.01739	Accepted
14	How likely blockchain improve synchronization between requirements?	218	0.94782	Rejected
15	How often blockchain help to gather authorized data	214	0.93043	Rejected

	from social media?			
16	How likely requirement negotiation process be improved by blockchain?	237	1.03043	Accepted
17	How often blockchain reduce time during requirement negotiation?	233	1.01304	Accepted
18	Can blockchain improve the speed of requirement negotiation?	231	1.00434	Accepted
19	Can blockchain framework easily be implemented in requirement negotiation?	200	0.86956	Rejected

4.1.1. Final result in sequence

The Weightage values from Table 4.2 are accurate and these are further organized in sequence to give a more clear view of accepted and rejected values. So here in Table 4.3 there factors are organized according to their Weightage values in descending order. The factors with higher Weightage values are listed on the top and the rejected factors are listed in the end of table.

Table 4. 3 Final result of survey

No	Factors	Weightage Values	Avg. Weightage Responses	Results
1	How likely is it that lack of communication in requirement negotiation leads to produce low quality projects?	335	1.45652	Accepted
2	Can the requirement negotiation process be improved by using some innovative technology?	278	1.20895	Accepted
3	Does requirement negotiation process consume more time in requirement elicitation and validation?	246	1.06956	Accepted
4	How likely requirement negotiation process be improved by blockchain?	237	1.03043	Accepted
5	Do weak algorithms in requirement negotiation produces low quality software projects?	236	1.02608	Accepted
6	Can blockchain improve communication gaps in requirement gathering?	235	1.02173	Accepted
7	Is requirement negotiation a time consuming process in crowd sourcing?	234	1.01391	Accepted
8	Can blockchain improve requirement negotiation through crowd sourcing?	234	1.01739	Accepted
9	Is it often complex to solve conflicts between stakeholders in requirement negotiation process?	233	1.01304	Accepted
10	Do you agree with the fact that the data gathered through social media in requirement negotiation is	233	1.01304	Accepted

	unauthorized?			
11	How often blockchain reduce time during requirement negotiation?	233	1.01304	Accepted
12	How likely blockchain can improve the quality of requirement negotiation?	232	1.00869	Accepted
13	Do you agree that elicitation, validation and prioritization complex is core problem?	231	1.00434	Accepted
14	Can blockchain improve the speed of requirement negotiation?	231	1.00434	Accepted
15	How likely blockchain improve synchronization between requirements?	218	0.94782	Rejected
16	How often blockchain help to gather authorized data from social media?	214	0.93043	Rejected
17	Would Blockchain easily solve the conflicts between stakeholders?	205	0.89130	Rejected
18	Can blockchain framework easily be implemented in requirement negotiation?	200	0.86956	Rejected
19	Do you agree that in requirement negotiation process requirements are less synchronized?	195	0.84782	Rejected

The values in Table 4.3 shows that the Weightage values equal to or more than 0.95 are accepted factor and the factors lower than 0.95 are rejected factors. So according to final Weightage values 5 factors rejected and 14 factors accepted.

4.1.2. Result explanation

The result factors acceptance and rejection criteria are on the bases of cronbach alpha values. The factors having lo significance are rejected and high significance is accepted.

4.1.2.1.Cronbach Alpha:

The value of cronbach alpha is 0.781548 which shows the consistency of these results that means these set of factors are closely related with each other and this data is consistent. Cronbach alpha is considered as the measure of scale reliability, and coefficient of reliability. Reliability coefficient of 0.70 or higher value is considered as "Accepted" result which means that results are consistent , reliable and can further be used.

4.1.2.2.Low significance factors

According to this result 5 factors are dropped out of 19 factors. The most common reason behind the rejection of these factors is this that there are more neutral (don't know)

values than positive or negative values. These don't know values shows that the participants don't have enough knowledge to give positive or negative remarks on these factors which is the reason of low significance of these factors or they don't know the answer because blockchain is not yet implemented in requirement engineering so they are not sure about the results. Following are the low significance factors:

1.   Do you agree that in requirement negotiation process requirements are less synchronized?

In the response of this factor most of the respondents are agree and neutral. Because of neutral response it shows that the respondents have less information about requirement synchronization and they are not sure about the results.

Weightage value = 195

Average Weightage responses = 0.84782

2.   Would Blockchain easily solve the conflicts between stakeholders?

In the response of this factor most respondents were agree some respondents were disagree and some were neutral. It means some respondents do not have information or idea of will blockchain solve conflicts between stakeholders because they have not sure about its results because no work is done yet. And some of the respondents do not think that blockchain will solve conflicts between stakeholders.

Weightage value = 205

Average Weightage responses = 0.89130

3.   How likely blockchain improve synchronization between requirements?

In the response of this factor most of the respondents are agree but some are disagree and neutral the high amount of neutral responses is the reason of low significance of this factor. The respondents have no idea about how likely blockchain improve the synchronization between stakeholders.

Weightage value = 218

Average Weightage responses = 0.94782

4.   How often blockchain help to gather authorized data from social media?

In the responses of this factor most of the respondents are disagree because they do not think that blockchain help to gather authorized data and some of the respondents do not have the knowledge to give agreement or disagreement.

Weightage value = 214

Average Weightage responses = 0.93043

5.   Can blockchain framework easily be implemented in requirement negotiation?

Most of the respondents in this survey are disagreed on this factor because they think that it is not easy to implement blockchain based framework in requirement negotiation. This is why the significance of this factor is very low. Because blockchain framework is not implemented yet and the respondents have no idea that how well this framework will be deployed and worked so they don't think that it is easy to implement blockchain framework in requirement negotiation for the first time. But according to respondents there is always a need of improvement so it will be difficult for the first time but it is possible to implement blockchain platform in requirement negotiation framework.

Weightage value = 200

Average Weightage responses = 0.86956

4.1.2.3.High Significance factors

The factors which are accepted are 14 out of 19 factors. These factors have high significance because participants have given positive remarks on these factors. Most of the participants are agree and strongly agree on these factors. These are the high significance factors:

1.   Do weak algorithms in requirement negotiation produces low quality software projects?

According to respondents it is obvious that the algorithms in requirement negotiation process can be improved to improve the quality of projects. The weak algorithms are most of the time reasons on low quality software projects.

2.   Is it often complex to solve conflicts between stakeholders in requirement negotiation process?

According to respondents it is complex to solve the conflicts between stakeholders it should be solved.

3.   How likely is it that lack of communication in requirement negotiation leads to produce low quality projects?

Respondents are agreed on that communication is basic problem when it comes to negotiation so communication issue should be resolved.

4.   Is requirement negotiation a time consuming process in crowd sourcing?

Yes respondents agreed that in crowdsourcing requirement negotiation is a time consuming task because the clients, stakeholders and all the members of groups have to cooperate with time from different locations so it is time consuming.

5. Do you agree with the fact that the data gathered through social media in requirement negotiation is unauthorized?

The respondents accept that the data is unauthorized which is gathered from social media because some time the data we are taking from social media is not from the authenticated source and the requirements gathered from social media is sometime ambiguous. So the gathered data should be authorized.

6. Do you agree that elicitation, validation and prioritization complex is core problem?

Yes respondents are agreed that in requirement negotiation process elicitation, validation and prioritization is core problem which should be improved.

7. Does requirement negotiation process consume more time in requirement elicitation and validation?

Respondent think that the requirement negotiation process consumes more time elicitation and validation of data so it is necessary to improve the process of requirement negotiation process.

8. Can the requirement negotiation process be improved by using some innovative technology?

Respondents are strongly agreed that there is always a room for improvement and innovations so the requirement negotiation process can be improved by using some innovative technology.

9. How likely blockchain can improve the quality of requirement negotiation?

The respondents are agreed that it is very likely that the efficient blockchain technology can improve the quality of requirement negotiation. Quality is the most important factor or requirement negotiation which is discussed in chapter 2 which is literature review of this thesis (2.2.2 Quality).

10. Can blockchain improve communication gaps in requirement gathering?

Respondents are strongly agreed that blockchain based framework can improve the communication gaps in requirement negotiation framework with its effective frameworks.

11. Can blockchain improve requirement negotiation through crowd sourcing?

Respondents are agreed that blockchain based framework can be implemented in requirement negotiation process to improve its quality in crowdsourcing. So that requirement negotiation through crowdsourcing will be improved.

12.   How likely requirement negotiation process be improved by blockchain?

Respondents are strongly agreed that the requirement negotiation process can be improved by implementation of blockchain based framework in it.

13.   How often blockchain reduce time during requirement negotiation?

Respondents agreed that the blockchain will reduce the time consumption of requirement negotiation process.

14.   Can blockchain improve the speed of requirement negotiation?

The respondents are strongly agreed on the fact that the speed of requirement negotiation process will be improved with the invention of blockchain based frame work, its decentralized and improved features.

These factors show that blockchain based framework will be effective in requirement negotiation process and the below factors are supporting the factors which are discussed in Chapter 2 of literature review 2.2. The high significance factors according to respondents show that:

- Algorithms used in requirement negotiation process produce low quality software projects
- It is complex to solve conflicts between stakeholders in requirement negotiation process
- Lack of communication in requirement negotiation is reason to produce low quality projects
- Requirement negotiation is time consuming process in crowd sourcing
- The data gathered through social media is unauthorized
- Requirement elicitation, validation and prioritization complexity is core problem in failure of software projects
- Requirement negotiation process can be improved by using innovative technology
- Blockchain can improve the quality of requirement negotiation process
- Blockchain can improve communication gap in requirement elicitation process
- Blockchain can improve requirement negotiation through crowdsourcing
- Requirement negotiation process can very likely be improved by blockchain

- Blockchain can often reduce time consumption during requirement negotiation process

- Blockchain can improve the speed of requirement negotiation process

These factors show that blockchain based framework will be effective in requirement negotiation process.

4.2.   Focus Group Results

Focus group is a qualitative method which is used for evaluation and validation of survey. Focus group was conducted among the sample size of 7 respondents who are the experts in software engineering and blockchain. These respondents are educated and they are experience in relevant fields. All the respondents are asked about their perception, belief and suggestion about the research questions according to their experience. Focus group helps to identify and improve ambiguities and missing or pointless questions. All the members of focus group are open to share their perspectives and beliefs in detail. Questions are asked from the members face to face or directly or members can freely discuss with each other. An online meeting was scheduled on Zoom application for which an invitation was sent to all of the population.

The population was the experts in software engineering and blockchain field. The sample size of focus group meeting was 7 who accepted the invitation to attend meeting. Then all the members were added in the zoom application on same time the meeting complete in 2 hour. All the members recorded their responses freely in a comfortable environment with in detail explanation and responses of all respondents were recorded and noted down. After that the responses of all the respondents are added in the Table 4.4.

Table 4. 4 Results from focus group data

No.	Factors	P1	P2	P3	P4	P5	P6	P7
1.	Do weak algorithms in requirement negotiation produces low quality software projects?	2	2	1	2	-1	2	2
2.	Is it often complex to solve conflicts between stakeholders in requirement negotiation process?	2	1	-1	2	-1	2	1
3.	How likely is it that lack of communication in requirement negotiation leads to produce low quality projects?	2	2	2	2	2	2	2
4.	Is requirement negotiation a time consuming process in crowd sourcing?	1	-1	2	1	-1	2	2
5.	Do you agree that in requirement negotiation process requirements are less synchronized?	-1	2	-1	-1	1	1	1
6.	Do you agree with the fact that the data gathered through social media in requirement negotiation is unauthorized?	2	2	2	2	2	2	2
7.	Do you agree that elicitation, validation and prioritization complex is core problem?	2	2	2	2	2	2	2
8.	Does requirement negotiation process consume more time in requirement elicitation and validation?	2	2	2	2	2	2	2
9.	Can the requirement negotiation process be improved by using some innovative technology?	2	2	2	2	2	2	2
10.	How likely blockchain can improve the quality of requirement negotiation?	2	1	2	-1	2	2	2
11.	Would Blockchain easily solve the conflicts between stakeholders?	2	2	2	2	2	2	2
12.	Can blockchain improve communication gaps in requirement gathering?	-2	-1	1	-2	-2	1	-1

13.	Can blockchain improve requirement negotiation through crowd sourcing?	2	2	2	2	2	2	2
14.	How likely blockchain improve synchronization between requirements?	2	2	1	2	2	-1	2
15.	How often blockchain help to gather authorized data from social media?	2	1	2	-1	2	2	2
16.	How likely requirement negotiation process be improved by blockchain?	2	2	2	2	2	2	2
17.	How often blockchain reduce time during requirement negotiation?	-1	1	-1	-1	2	1	1
18.	Can blockchain improve the speed of requirement negotiation?	-1	2	2	1	2	2	2
19.	Can blockchain framework easily be implemented in requirement negotiation?	-2	-1	-2	1	-2	1	-1

Likert Scale for focus group responses

The responses are analyzed according to Likert scale to get average Weightage values. The responses from respondents are multiplied with the values of Likert scale values. Strongly agree responses are multiplied with 2, agreed responses are multiplied with 1, neutral responses are multiplied with 0, disagreed responses are multiplied with –1 and strongly disagreed responses are multiplied with -2. A. At the end these values are added to get total value. After that these total values are divided by total number of responses which is 7.

0= Agree,   1=Disagree

Strongly Agree (2)	Agree (1)	Neutral (0)	Disagree (-1)	Strongly Disagree (-2)

Table 4. 5 Likert Scale for focus group responses

No.	Factors	P1	P2	P3	P4	P5	P6	P7	Agree*2	Disagree*-2	result	Average Weightage
1.	Do weak algorithms in requirement negotiation produces low quality software projects?	2	2	1	2	-1	2	2	6=12	1=-2	10	1.42857
2.	Is it often complex to solve conflicts between stakeholders in requirement negotiation process?	2	1	-1	2	-1	2	1	5=10	2=-4	6	0.857142
3.	How likely is it that lack of communication in requirement negotiation leads to produce low quality projects?	2	2	2	2	2	2	2	7=14	0=0	14	2
4.	Is requirement negotiation a time consuming process in crowd sourcing?	1	-1	2	1	-1	2	2	5=10	2=-4	6	1.42857
5.	Do you agree that in requirement negotiation process requirements are less synchronized?	-1	2	-1	-1	1	1	1	4=8	3=-6	2	0.28571
6.	Do you agree with the fact that the data gathered through social media in requirement negotiation is unauthorized?	2	2	2	2	2	2	2	7=14	0=0	14	2
7.	Do you agree that elicitation, validation and prioritization complex is core problem?	2	2	2	2	2	2	2	7=14	0=0	14	2
8.	Does requirement negotiation process consume more time in requirement elicitation and validation?	2	2	2	2	2	2	2	7=14	0=0	14	2
9.	Can the requirement negotiation process be improved by using some innovative technology?	2	2	2	2	2	2	2	7=14	0=0	14	2

10.	How likely blockchain can improve the quality of requirement negotiation?	2	1	2	-1	2	2	2	6=12	1=-2	10	1.42857
11.	Would Blockchain easily solve the conflicts between stakeholders?	2	2	2	2	2	2	2	7=14	0=0	14	2
12.	Can blockchain improve communication gaps in requirement gathering?	-2	-1	1	-2	-2	1	-1	2=4	5=-10	-6	0.85714
13.	Can blockchain improve requirement negotiation through crowd sourcing?	2	2	2	2	2	2	2	7=14	0=0	14	2
14.	How likely blockchain improve synchronization between requirements?	2	2	1	2	2	-1	2	6=12	1=-2	10	1.42857
15.	How often blockchain help to gather authorized data from social media?	2	1	2	-1	2	2	2	6=12	1=-2	10	1.42857
16.	How likely requirement negotiation process be improved by blockchain?	2	2	2	2	2	2	2	7=14	0=0	14	2
17.	How often blockchain reduce time during requirement negotiation?	-1	1	-1	-1	2	1	1	4=8	3=-6	2	0.28571
18.	Can blockchain improve the speed of requirement negotiation?	-1	2	2	1	2	2	2	6=12	1=-2	10	1.42857
19.	Can blockchain framework easily be implemented in requirement negotiation?	-2	-1	-2	1	-2	1	-1	2=4	5=-10	-6	0.85714

The results (Weightage values) from above Table 4.5 shows that the Weightage values lower than 0.95 are rejected and the values equal to or above 0.95 are accepted values.

Final Results from Focus Group

The final results of focus group with their Weightage values are shown in below Table 4.6 through focus group meeting.

Table 4. 6 Final Results from Focus Group

No.	Factors	Average weighted	Final Results
1.	Do weak algorithms in requirement negotiation produces low quality software projects?	1.42857	Accepted
2.	Is it often complex to solve conflicts between stakeholders in requirement negotiation process?	0.857142	Rejected
3.	How likely is it that lack of communication in requirement negotiation leads to produce low quality projects?	2	Accepted
4.	Is requirement negotiation a time consuming process in crowd sourcing?	1.42857	Accepted
5.	Do you agree that in requirement negotiation process requirements are less synchronized?	0.28571	Rejected
6.	Do you agree with the fact that the data gathered through social media in requirement negotiation is unauthorized?	2	Accepted
7.	Do you agree that elicitation, validation and prioritization complex is core problem?	2	Accepted
8.	Does requirement negotiation process consume more time in requirement elicitation and validation?	2	Accepted
9.	Can the requirement negotiation process be improved by using some innovative technology?	2	Accepted
10.	How likely blockchain can improve the quality of requirement negotiation?	1.42857	Accepted
11.	Would Blockchain easily solve the conflicts between stakeholders?	2	Accepted
12.	Can blockchain improve communication gaps in requirement gathering?	0.85714	Rejected
13.	Can blockchain improve requirement negotiation through crowd sourcing?	2	Accepted
14.	How likely blockchain improve synchronization between requirements?	1.42857	Accepted
15.	How often blockchain help to gather authorized data from social media?	1.42857	Accepted

16.	How likely requirement negotiation process be improved by blockchain?	2	Accepted
17.	How often blockchain reduce time during requirement negotiation?	0.28571	Rejected
18.	Can blockchain improve the speed of requirement negotiation?	1.42857	Accepted
19.	Can blockchain framework easily be implemented in requirement negotiation?	0.85714	Rejected

The result from Table 4.6 shows that 5 factors are rejected and other 14 factors are accepted.

4.2.1. The low significance factors according to focus group are:

- Is it often complex to solve conflicts between stakeholders in requirement negotiation process?
- Do you agree that in requirement negotiation process requirements are less synchronized?
- Can blockchain improve communication gaps in requirement gathering?
- How often blockchain reduce time during requirement negotiation?
- Can blockchain framework easily be implemented in requirement negotiation?

According to focus group respondents it is difficult to solve conflicts between stakeholders, improve communication gaps in requirement gathering, reduce time during requirement negotiation, to implement framework in requirement negotiation with problems, and there is synchronization in requirements in requirement negotiation process.

As compare to survey two factors are commonly rejected in both methods which are

1. Do you agree that in requirement negotiation process requirements are less synchronized?
2. Can blockchain framework easily be implemented in requirement negotiation?

4.2.2. The accepted or high significance factors according to focus group

- Algorithms used in requirement negotiation process produce low quality software projects
- Lack of communication in requirement negotiation is reason to produce low quality projects
- Requirement negotiation is time consuming process in crowd sourcing
- The data gathered through social media is unauthorized

- Requirement elicitation, validation and prioritization complexity is core problem in failure of software projects

- Requirement negotiation process consume more time in requirement elicitation and validation

- Requirement negotiation process can be improved by using innovative technology

- Blockchain can improve the quality of requirement negotiation process

- Blockchain would easily solve the conflicts between stakeholders

- Blockchain can improve requirement negotiation through crowdsourcing

- Blockchain will very likely improve synchronization between requirements

- Blockchain will help to gather authorized data from social media

- Requirement negotiation process can very likely be improved by blockchain

- Blockchain can improve the speed of requirement negotiation process

  These factors show that blockchain based framework will be effective in requirement negotiation process.

  These factors are most commonly accepted by survey as well. To further justify the results these results will be further analyzed in chapter 5.

4.3. Analysis

The final results from both focus group and survey shows that respondents from both methods accepted most of the factors and few rejected factors in both methods are same. According to the survey result 5 factors were rejected from 19 factors. The most common reason behind the rejection of these factors is this that there are more neutral (don't know) values than positive or negative values. These don't know values shows that the participants don't have enough knowledge to give positive or negative remarks on these factors which is the reason of low significance of these factors or they don't know the answer because blockchain is not yet implemented in requirement engineering so they are not sure about the results. The rejected factors in survey are synchronization in requirements, conflicts between stakeholders, gather authorized data and implementation of blockchain framework. Focus group members also rejected some factors in which synchronization between requirements, conflicts between stakeholders, implementation of framework are most rejected factors.

According to focus group respondents it is difficult to solve conflicts between stakeholders, improve communication gaps in requirement gathering, reduce time during requirement negotiation, to implement framework in requirement negotiation with problems, and there is synchronization in requirements in requirement negotiation process.

As compare to survey two factors are commonly rejected these repeatedly rejected factors are:

- Do you agree that in requirement negotiation process requirements are less synchronized?
- Can blockchain framework easily be implemented in requirement negotiation?

4.4. Summary

The results from survey and focus group are analyzed and evaluated in this chapter in which the rejected values and accepted factors of both methods are further analyzed the common rejected factors in both survey and focus group are discussed. The main two factors are rejected commonly in both methods which are the synchronization between requirements and implementation of blockchain framework in requirement negotiation process. Chapter 5 will further analyze the result using a justification method to give the final and most accurate answers from comparing both methods.

Chapter 5

Results and Analysis

After evaluation of both results of survey and focus group in this chapter these results will further be analyzed to get a single more justified and accurate answer. The answer by comparison of both survey and focus group will be the final answer of this research and will be helpful in development of framework using blockchain based technology for requirement negotiation process.

5.1. Triangulation Process

Triangulation is a process of validation of two or more methods used for research. In this research survey is conducted to answer the research questions and objectives. To evaluate and validate the results of survey focus group was conducted which is a qualitative method. After the results of focus group there was a need to compare the results of both methods and get the final more justified results. To further analyze and justify the results a triangulation process is applied on both results of survey and focus group. The final results by comparison from both results of survey and focus group will be the more precise and justified data. The final results show that which factors are rejected and which factors have high significance to be accepted.

This is the last step of getting a final result which will help to support the research paper as we have discussed above that the positive responses will show that the experts are agree that there are limitations in factors of requirement negotiation process. Because of the limitations in requirement negotiation process the requirements are gathering and negotiation is complex and time taking process. This is very challenging for the developers and researchers to find the exact requirements of user and to create successful and reliable projects. So to improve these limitations in factors of requirement negotiation process there is a need of blockchain based framework which will help to make requirement negotiation process more easy and reliable. In below Table 5.1 shows the comparison between results of both methods which gives the more accurate results.

Table 5. 1 Comparison in results

No.	Questions	Survey	Focus Group	Validated values	Final Results
1.	Do weak algorithms in requirement negotiation produces low quality software projects?	1.02608	1.42857	1.42857	Accepted
2.	Is it often complex to solve conflicts between stakeholders in requirement negotiation process?	1.01304	0.857142	0.857142	Rejected
3.	How likely is it that lack of communication in requirement negotiation leads to produce low quality projects?	1.45652	2	2	Accepted
4.	Is requirement negotiation a time consuming process in crowd sourcing?	1.01391	1.42857	1.42857	Accepted
5.	Do you agree that in requirement negotiation process requirements are less synchronized?	0.84782	0.28571	0.28571	Rejected
6.	Do you agree with the fact that the data gathered through social media in requirement negotiation is unauthorized?	1.01304	2	2	Accepted
7.	Do you agree that elicitation, validation and prioritization complex is core problem?	1.00434	2	2	Accepted
8.	Does requirement negotiation process consume more time in requirement elicitation and validation?	1.06956	2	2	Accepted
9.	Can the requirement negotiation process be improved by using some innovative technology?	1.20895	2	2	Accepted
10.	How likely blockchain can improve the quality of requirement negotiation?	1.00869	1.42857	1.42857	Accepted
11.	Would Blockchain easily solve the conflicts between stakeholders?	0.89130	2	2	Accepted

12.	Can blockchain improve communication gaps in requirement gathering?	1.02173	0.85714	0.85714	Rejected
13.	Can blockchain improve requirement negotiation through crowd sourcing?	1.01739	2	2	Accepted
14.	How likely blockchain improve synchronization between requirements?	0.94782	1.42857	1.42857	Accepted
15.	How often blockchain help to gather authorized data from social media?	0.93043	1.42857	1.42857	Accepted
16.	How likely requirement negotiation process be improved by blockchain?	1.03043	2	2	Accepted
17.	How often blockchain reduce time during requirement negotiation?	1.01304	0.28571	0.28571	Rejected
18.	Can blockchain improve the speed of requirement negotiation?	1.00434	1.42857	1.42857	Accepted
19.	Can blockchain framework easily be implemented in requirement negotiation?	0.86956	0.85714	0.85714	Rejected

Final more justified and validated result from triangulation process shows that most of the factors are accepted and five factors are rejected. These five factors are:

5.1.1. Low Significance Factors in final results:

F1: Do you agree that in requirement negotiation process requirements are less synchronized?

F2: Can blockchain framework easily be implemented in requirement negotiation?

F3: How often blockchain reduce time during requirement negotiation?

F4: Can blockchain improve communication gaps in requirement gathering?

F5: Is it often complex to solve conflicts between stakeholders in requirement negotiation process?

As according to the respondents there is synchronization between requirements and these requirements need further improvement in their negotiation process. Also according to target population it is not easy to implement a new framework in requirement negotiation process. But there is a possibility of improvement in requirement negotiation process using some blockchain technology.

5.1.2. High significance factors according to final results:
- Algorithms used in requirement negotiation process produce low quality projects
- Lack of communication in requirement negotiation produce low quality projects
- Requirement negotiation is time consuming process in crowd sourcing
- The data gathered through social media is unauthorized
- Requirement elicitation, validation and prioritization complexity is core problem in failure of software projects
- Requirement negotiation process consume more time in requirement elicitation and validation
- Requirement negotiation process can be improved by using innovative technology
- Blockchain can improve the quality of requirement negotiation process
- Blockchain would easily solve the conflicts between stakeholders
- Blockchain can improve requirement negotiation through crowdsourcing

- Blockchain will very likely improve synchronization between requirements

- Blockchain will help to gather authorized data from social media

- Requirement negotiation process can very likely be improved by blockchain

- Blockchain can improve the speed of requirement negotiation process

5.2. Framework

As according to Chapter 2 literature review and the final results there is a need for improvement in requirement negotiation process using blockchain based framework. This framework will help to:

- Solve conflicts between stakeholders in requirement negotiation process

- Improve quality of algorithms

- Improve communication gap

- Improve time consumption in crowd sourcing for requirement negotiation

- Solve requirement elicitation, validation and prioritization process

- Reduce time consumption in requirement elicitation and validation

- Improve the quality of requirement negotiation process

- Improve synchronization between requirements

- Gather authorized data from social media

- Reduce time during requirement negotiation

- Improve the speed of requirement negotiation process

In this blockchain based framework for requirement negotiation there will be three main objects. These three objects have their specific functionalities which are given below:

1. Requirement pool
2. Decentralized network
3. Distributed Ledger

Step 1: Requirement pool

Requirement pool will be a system in which all the requirements gathered from customer, social media or any other crowdsourcing platform will be added. This requirement pool is will be full of all functional or non functional requirements and some requirements will only be useless for software development. In these requirements it is difficult to implement a successful system because by implementing system on rough requirements some of non functional requirements take more time, budget and efforts. So it is necessary to

develop systems on most important requirements first after that if time and budget is available than implement non functional requirements. So, to implement most validated and prioritized requirements all the requirements in requirement pool will be transfer to decentralized network.

Step 2: Decentralized Network

Once the requirements are added in requirement pool these requirements will send one by one to a decentralized network. In this decentralized network all the stakeholders including software development experts, developers, software engineers and concerned sources will be connected from all around the world to this decentralized network. The duty of these software experts and developers is to vote the requirements according to their experiences. Some of the stakeholders will validate a specific requirement and some will reject the requirement. The rejected votes mean that these are not useful requirements for developing specific software.

Step 3: Distributed Ledger

A database will be distributed among all the stakeholders in this database all the requirements will be added for voting one by one from requirement pool. This ledger is not centralized and shared among all the stakeholders. No one can make changes in this shared ledger without permission by system. The system will only give the read and write permission to management or upper authority. No outsider will be able to success the system because system will only add the stakeholders who are authorized by the management. When the requirements will be shared from requirement pool, all the stakeholders will give their voting accordingly from different location and on different time. And after voting from all stakeholders on all requirements final result will be added in data base. This final and validated result will be distributed among all the stakeholders.

After voting from stakeholders the distributed ledger will show the finalized result by analyzing the votes and prioritizing them. The requirements, on which most of the stakeholders are agree, will be the most validated and prioritized requirements and will be shown on the top of result list. The requirements with fewer votes will be shown on the end of the list. This voting scheme will remove the communication issues between stakeholders and the negotiation problems will also be solved. There will be no biasness in results and final result will more synchronized, consistent, validated and well negotiated requirements.
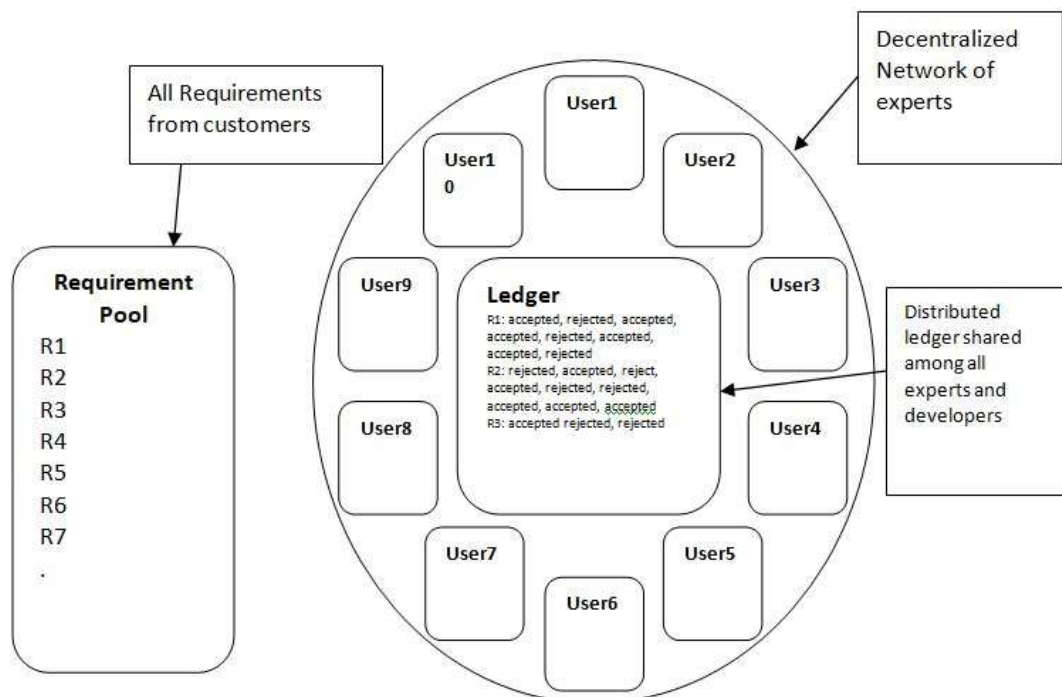
Figure 5. 1 Framework components

5.2.1. Explanation of Framework

There is a need of improvement in factors of requirement negotiation process. These factors can be improved by using an innovative technology. A blockchain based framework is introduced to improve the requirement elicitation, validation, and prioritization and negotiation process. Blockchain framework is adapted to create a decentralized network, because blockchain is a decentralized technology which makes it secure and easy to accessible. Blockchain is adapted in many organizations and applications because of its quality, security and consistency. So for the improvement of projects and to reduce the failure rate of projects blockchain oriented requirement engineering is introduced in this research to make requirement engineering process more verified and easy. Blockchain is secured and distributed ledger technology which provides an immutable record of transactions. Blockchain is decentralized online global database so its ledger is shared among all stakeholders. Through this decentralized all the transactions are recorded in computer and this ledger is shared by every computer around the world and anyone can access these transactions and add transactions but cannot change ledger after transactions are added in

ledger. The concept of blockchain is now adapted in every field and requirements for trustworthy of records management.

To improve the requirement negotiation process blockchain oriented frameworks is developed which will help to improve the requirement elicitation, validation, and negotiation and prioritization process more accurately.

The framework introduced in this research consists of requirement pool, distributed ledger and stakeholders. First step is to gather the requirements all the requirements from any source will be added to requirement pool. The requirement pool will be eventually full of all functional, nonfunctional or may contain completely useless requirements. After all the requirements will be added in requirement pool than requirement 1 (R1) will be sent to the distributed ledger. This distributed ledger will be shared among all the experts, developers and other sources connected from different locations. All the stakeholders will check and vote the R1 from shared database. Stakeholders will one by one check the requirement R1 some will mark it as valid requirement and some of them will reject requirement R1.
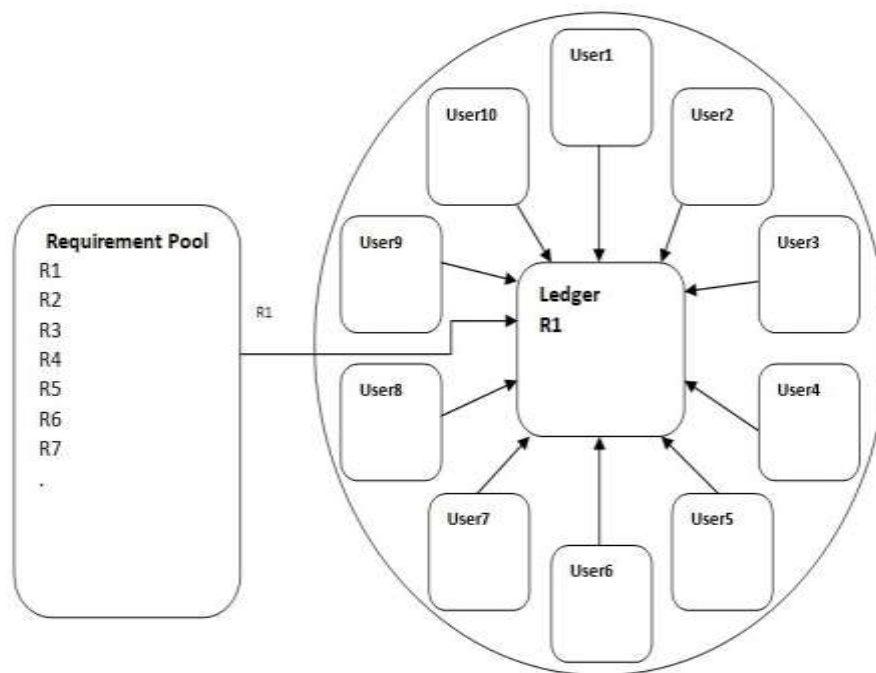

Figure 5. 2: Framework development Phase 1

Some of the stakeholders will accept the R1 to be used for development of software project but some experts will reject the R1. The votes of all stakeholders will be added in result table and system will analyze that 7 experts accepted the R1 and 3 experts rejected R1

so the number of rejection is less than accepted votes, So R1 is valid requirement and it will be used in software development. Same like R1 requirement 2 (R2) will be added from requirement pool to distributed ledger then all the stakeholders will give their votes on R2 and the votes of all stakeholders will be saved in result table which will show that 4 experts accepted R2 to use in development of project but 6 stakeholders were disagreed on R2. So the number of rejected votes in greater than accepted votes R2 is invalid requirement and it will not be used in software development.
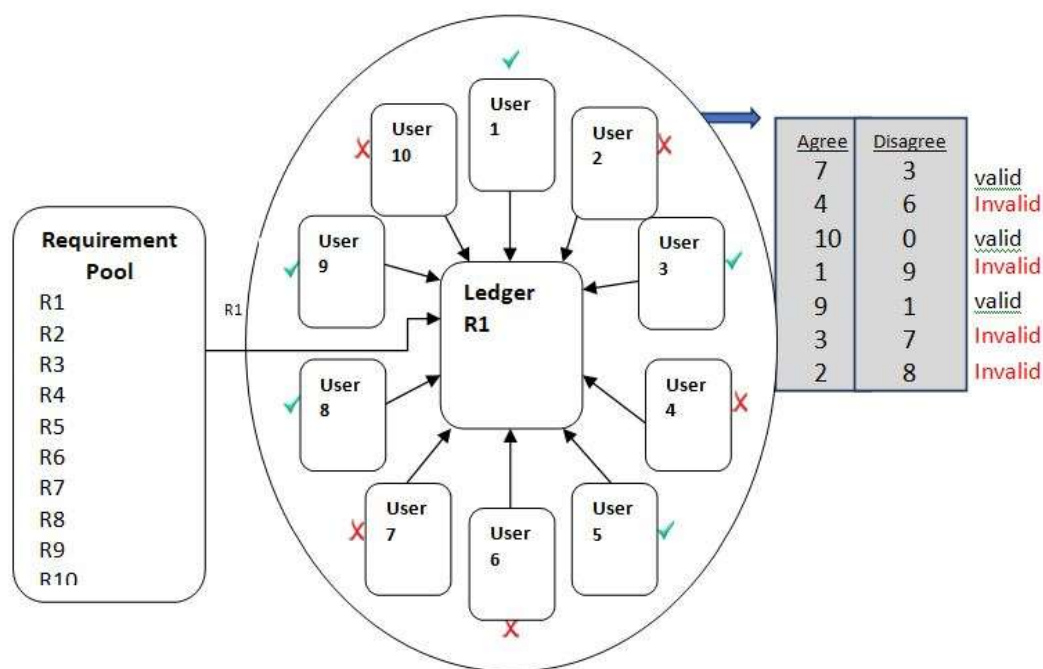

Figure 5. 3 Framework for Requirement Negotiation using Blockchain

Just like R1 and R2 all the requirements will be added in shared ledger one by one and experts will vote each requirement one by one and results of all requirements will be added in result table simultaneously. In the result table if number of accepted votes is lower than rejected votes than the requirement will be invalid and rejected it will not be used in software development. If number of accepted votes is greater than rejected votes then the requirement will be validated and accepted to use in software development. Most accepted requirements will have high prioritization and less accepted requirements will be after those most prioritized requirements. The sequence of requirements will automatically be arranged in database according to their number of accepted votes.

- This voting process will solve conflicts between stakeholders
- Improve quality of algorithms

- Improve communication gap by simply voting

- Elicitation, validate and prioritize requirements

- Reduce time consumption in requirement elicitation and validation

- Improve the quality of requirement negotiation process

- Improve synchronization between requirements

- The requirements accepted will be authorized by experts

- Improve the speed of requirement negotiation process

5.3.   Examples:

Two case studies are taken to explain the implementation of blockchain technology as a solution of different problems.

5.3.1.   Case Study 1

Patient information system for mental health care

It is a patient information system to support medical health care it maintains the information about patients who are suffering from mental health problems. The issues with this system are:

- System database is centralized

- Anyone can access and use the patient information

- Can be used from sites that are not secured

- Not a complete medical record

- Interact and exchange data with other clinical information systems

Solution of Case Study 1

A blockchain framework can be used to improve the security and accessibility of database and the record will be decentralized so that any unauthorized change in the data will be monitored. The blockchain based framework will give the authority only to the patients their relatives, staff members other medical information systems. All the members including patents will be able to check record. The admin officer will only have the permission to add changes in the record of the patient. Only admin officer will have the permission to write on database others will only check the database and contact with admin office for addition of latest treatments and medicines.

A blockchain based framework will be developed for patient information system for healthcare. This framework has a pool in which all the information old medical records of

patients are added by the system. These records are than shared in a decentralized network. In this decentralized network all network all the authorized and authenticated hospitals, websites, doctors and patients are added. The management will give read and write authority to only security department of hospital, doctors, hospitals and management itself. Patient will only be able to read the record and recent updates regarding to him. The stakeholders will complete the record according to patient condition.
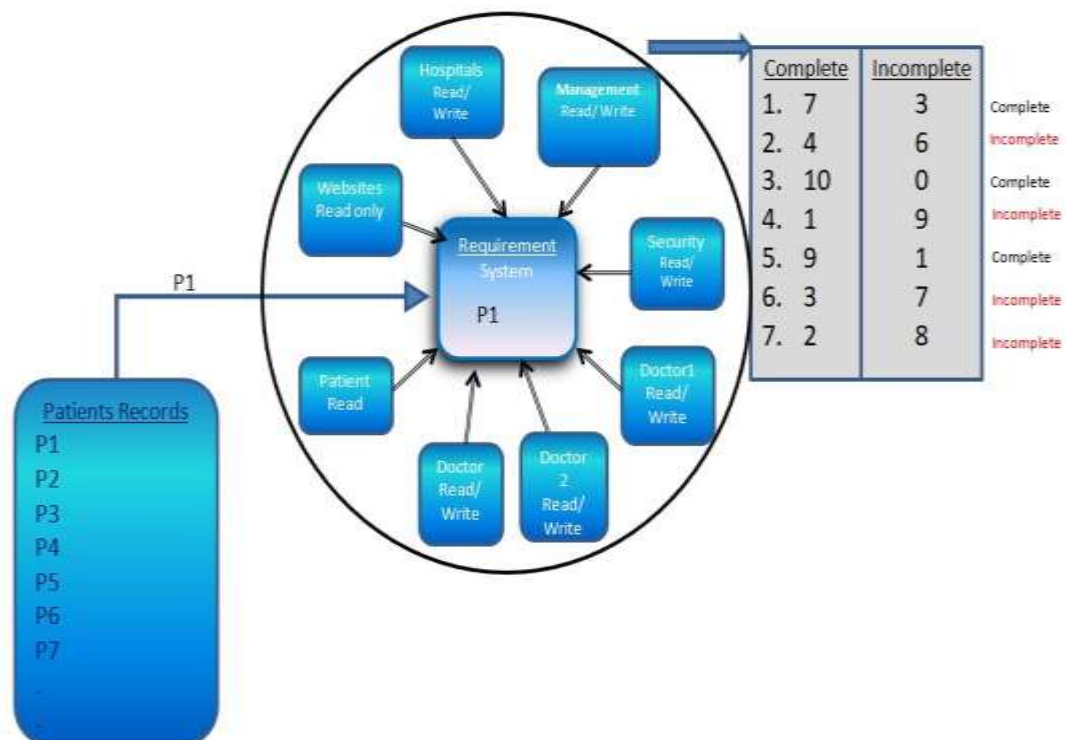

Figure 5. 4: Case Study, Framework for Patient Information System

The stakeholders will give reviews that this is complete record of patient or this is incomplete. Then management will consult the doctors of that patient and complete record. So the results will be shared with all stakeholders, which will show that the records are complete or incomplete. This will help to complete and focus on the specific records of patients to complete.

By implementation of this framework the data will be shared with other clinical authorities and the data will be decentralized. This will secure the records of stakeholder by allowing access only to the consulting authorized organizations and websites and will help to give complete records of patients.

5.3.2. Case Study 2

A System for Project Management

In a company there are four types of stakeholders:

1. Company Management
2. System Administrator
3. Project Team Leader
4. Project Team Members.

The company team managers is using or some are not using software for maintaining and keeping track of schedule of project. Because of which company faces many problems such as:

- Difficult to get overview of project status.
- Because there is no common standard for important project information it is difficult to move or change project leaders.
- Management faces problem understanding the effect of changed circumstances such as a delay in one part of the project the team member unavailability.
- Marketing face hurdles in obtaining realistic costs for change requests by customers or initial offers to new customers, as comparable tasks are not available.

All Company Management, System Administrator, Project Team Leader and Project Team Members need system for project management according to their needs.

Solution of Case Study 2

Blockchain based framework is a solution to produce good quality and secured systems. Blockchain technology is decentralized innovative technology in which a distributed ledger is shared among all the stakeholders and the ledger is secured and easily accessible. A blockchain framework based software application can be developed in a way that the data will be decentralized and secured, the upper management and team members can check the project updated in which they are enrolled but only manger can make changes on daily bases it shows

- The type, name and updates of project according to type of stakeholder, either he is a team manager, administrator or team leader.
- Show the overview of project status
- The managers, team members will regularly set the goals and update the achievements.

- The system will be secured that

- Will easily keep track of projects

- Show the exact time frame till completion of project

- Schedule will be set by each individual on their own system

So the solution of this case study is the implementation of blockchain technology because it is most widely used and adopted in several projects to make them secure and reliable. The ledger in blockchain technology will be more secured and effective and it will make the project easy to access and use.
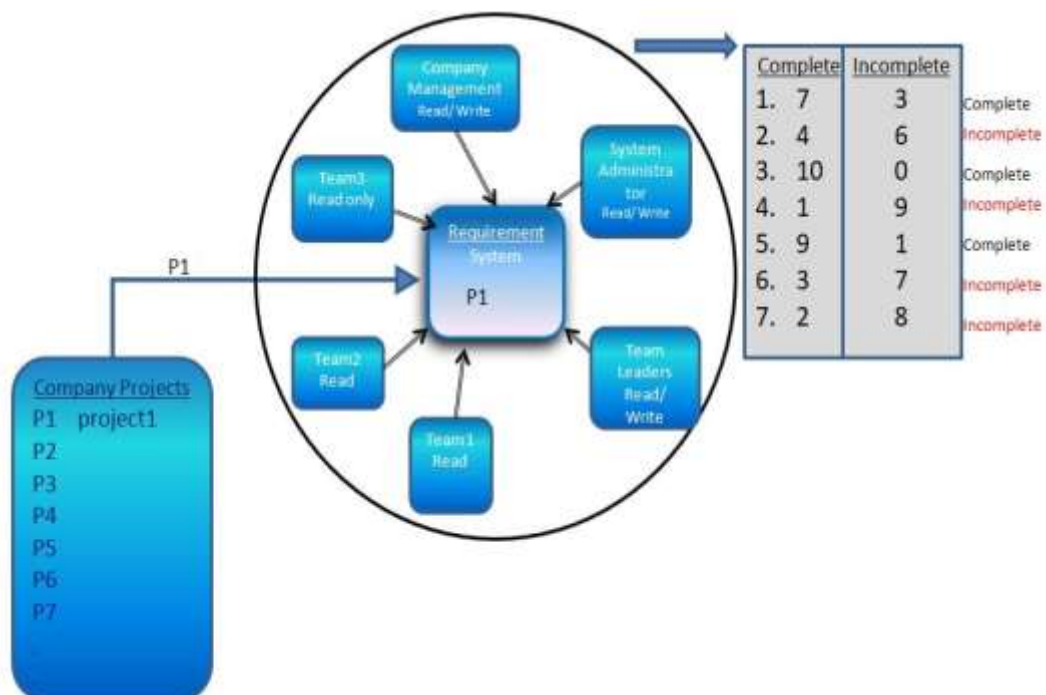

Figure 5. 5: Case Study2, Framework for project management system

In this blockchain based framework all the current projects will be added in the company project pool. This pool will send the projects to the decentralized system in which all the company management, system administrators, team leaders and team members will be added. These stakeholders will be able to check daily updates regarding to the shared projects. The system will give authority only to the company management, team leaders, and system administrator to read and write the updates according to projects. Team members will be able to check daily updates and tasks assign to them and will daily give their report on given tasks. The upper management team leaders will check the report of team members and update their report about projects.

This will help to give the overview of project completion. The system will give authority to new project leaders and remove the leaders who are not connected to the organization. Daily reporting on project will increase the performance of all the stakeholders and all the parts of projects will equally be completed. The changes made by customer will be updated in the distributed ledger accordingly due to which the latest strategies and tasks will be assigned to all the stakeholders. These stakeholders will work on their assign tasks and update the completion report at the end of day. This blockchain based framework will help to improve the efficiency, performance, reliability and quality of system for project management.

5.4. Discussion

As according to the final results from triangulation process two factors are rejected which means there is a need of improvement in many requirement negotiation factors. The respondents are agree in the fact that there is a need of improvement in requirement negotiation process and the blockchain based framework can be implemented in requirement negotiation process for improvement. Further a framework is developed which is using features of blockchain technology to make requirement negotiation process improved, fast, easy and reliable. The final results are supporting our research and shows that blockchain adoption will be helpful in the field of requirement negotiation. This will make requirement elicitation, validation, prioritization and negotiation process more improved and less time and efforts will be consumed in this process. Requirement negotiation process will be more reliable and the requirements will be more consistent.

The conflicts between stake holders will be solved by voting algorithm and the requirements will have quality and they will be more prioritized. Blockchain based framework will be helpful for researchers, students and developers as well. Also the quality requirements will produce quality products so it will also help society by quality and reliable products and projects.

5.5. Comparative analysis

Blockchain framework will improve the quality and functionality of requirement negotiation process with its decentralized and online features. When the requirements will send to the stakeholders from the requirement pool than the stakeholders will give their votes

on the requirements. This voting techniques and the stakeholder's availability from all around the world will make the increase the speed of requirement negotiation process and the quality of requirement negotiation process will also be improved. Most importantly requirement will be validated and prioritized which will help to reduce time and efforts utilization on nonfunctional and mixed requirements. The requirements will be filtered out and cleaned. The project success rate will be increased.

5.6.   Conclusion

In this chapter we have discussed and applied triangulation process to compare the results of both methods focus group and survey. The final result is justified and accurate which shows that there is a need of improvement in requirement negotiation process and many factors of requirement negotiation process should be improved with latest technology and blockchain framework can improve the quality and reliability of requirement negotiation process. After that a framework is introduced which will help to generate the good quality requirements, well prioritized requirements, highlight functional requirements, remove the unnecessary or ambiguous requirements, the requirement negotiation process will be fast and improved.

Chapter 6

Conclusion

6.1. Research Questions

RQ1: What is the state of art in requirement negotiation?

To respond this question we identified and analyzed challenges with qualitative method is done and then to further validate these challenges a qualitative study is conducted which is a focus group method to take in-depth and clearer reviews of respondents. After conducting and analyzing both methods a triangulation process compared results of both qualitative and quantitative methods and selected dominant values as final results. This result finally helped in giving most important challenges that can further be improved with innovative technology. 9 questions were raised to support this question. Challenges raised in requirement negotiation process are weak algorithms produce low quality software projects, complex to solve conflicts between stakeholders in requirement negotiation process, lack of communication in requirement negotiation process produce low quality projects, requirement negotiation is a time consuming process in crowd sourcing, in requirement negotiation process requirements are less synchronized, data gathered through social media is unauthorized in requirement negotiation process, requirement elicitation , validation and prioritization complexity is core problem in requirement negotiation process, requirement negotiation process consumes more time in requirement elicitation and validation process, requirement negotiation process can be improved by using some innovative technology. Respondents gave their responses on all these challenges using both qualitative and quantitative methods.

Methods and Results

A survey was conducted on research questions to find the results and responses of experts to make the research questions more accurate and strong. The results from survey shows that the challenges raised are valid and the requirement negotiation process need further improvement with implementation of some innovative technology to improve quality

and sustainability of information systems. Research question 1 raised challenges in requirement negotiation process these challenges are, weak algorithms, conflicts between stake holders, communication issues, time consumption in crowd sourcing, less synchronization in requirements, unauthorized data through social media, requirement elicitation validation and prioritization are core problems and time consuming. The respondents are disagreed on one factor that requirements synchronization is not the challenge that should be consider to improve the quality of requirement negotiation process. Respondents are agreeing on all other challenges raised in research question 1. To validate these challenges a qualitative study is done , a focus group is conducted and the results of focused group shows that all of the respondents accepted all the challenges but rejected two challenges which are that it is complex to solve conflicts between stakeholders and less synchronized requirements.

By analyzing results and triangulation process the final results shows that all the raised challenges are accepted by the respondents except only one challenge which is less synchronization in requirements. Data gathered through both qualitative and quantitative methods was analyzed to get more justified and accurate results. After analysis of both methods triangulation process is done which gives the more specific and dominant values. The results show that there are many challenges in requirement negotiation process according to experts. These challenges are: weak algorithms produce low quality software projects, complex to solve conflicts between stakeholders in requirement negotiation process, lack of communication in requirement negotiation process produce low quality projects, requirement negotiation is a time consuming process in crowd sourcing, data gathered through social media is unauthorized in requirement negotiation process, requirement elicitation , validation and prioritization complexity is core problem in requirement negotiation process, requirement negotiation process consumes more time in requirement elicitation and validation process, requirement negotiation process can be improved by using some innovative technology.

The rejected challenge is the synchronization in requirements. The respondents are disagreed that the requirements are less synchronized.

RQ2: How blockchain based framework can help in improving the requirement engineering process?

To respond this question we identified and analyzed challenges with quantitative method and then to further validate these challenges a qualitative method is conducted which is a focus group method to take in-depth and clearer reviews of respondents. After conducting and analyzing both methods a triangulation process compared results of both qualitative and quantitative methods and selected dominant values as final results. This result finally helped in giving most important challenges that can further be improved with innovative technology. Challenges raised in requirement negotiation process are: can blockchain improve quality of requirement negotiation, easily solve conflicts between stakeholders, improve communication gaps in requirement gathering, improve requirement negotiation through crowd sourcing, improve synchronization between requirements, help to gather authorized data from social media, requirement negotiation process be improved by blockchain, reduce time during requirement negotiation, improve the speed of requirement negotiation, Can blockchain framework easily be implemented in requirement negotiation.

Methods and Results

Same like research question 1 a survey was conducted on research question 2 which is how blockchain can help in improvement of requirement negotiation process. The above listed challenges can be improved by using blockchain or not this is the purpose of research question 2. The respondents are agree on the facts that blockchain can improve algorithms, communication issues, time consumption in crowd sourcing, requirement elicitation validation and prioritization are core problems and time consuming. But the respondents are disagreed that the blockchain can improve synchronization between requirements, gather authorized data from social media, solve conflicts between stakeholders and blockchain can easily be implemented in requirement negotiation process.

To verify this result a focus group was conducted and the results of focused group accepted all the factors except three factors. The rejected factors are communication gap issue, blockchain reduce time during requirement negotiation, and blockchain framework can easily be implemented in requirement negotiation?

By analyzing results and triangulation process the final results shows that all the raised challenges are accepted by the respondents except one, according to respondents it is not easy to implement blockchain framework in requirement negotiation.

6.1.1. Final Results of Research Questions

So the final result shows that two questions are rejected which are synchronization in requirements and difficulty to implement blockchain framework in requirement negotiation. Validated and prioritized requirements will directly synchronize the requirements in consistency and a right sequence. Since there is no practical work done in this field so there is no exact answer that is it easy to implement or is it difficult to implement blockchain framework in requirement negotiation process.

The research questions in literature review are addressed by conducting systematic literature review. Many factors are identified in literature review these factors are time, communication, conflicts, decision making, crowd sourcing, synchronization, authorization and complexity. Mixed method research was conducted to validate these challenges according to RQ1. Than a framework is introduced which was also validated by mixed method research. The finalized result supports the research questions and shows that requirement negotiation process can be improved using blockchain based framework.

6.2. Contribution

There are two types of contributions in this research:

6.2.1. Methodological Contribution
- The use of blockchain platform in requirement engineering will help to gather correct complete requirements with efficiency.
- Requirement engineering processes can be more secure and easily accessible.
- Stakeholders can easily contribute/gather authorized requirements which will reduce their time and efforts.
- With improved quality of requirements
- Ensure consistency and synchronization of requirements.
- Failure rate of projects will be reduced.
- Rate of successful projects will be increased.

6.2.2. Research Contribution
- The researchers will easily negotiate for data elicitation and validation

- The students will further use blockchain for better performance of methods and algorithms used in software engineering.
- The quality of the requirement negotiation process will also be improved and help researchers to gather quality data.

6.3. Motivation

Requirement negotiation process has several factors during software development life cycle. Some of these factors are discussed in this work to identify the lacks in the field of requirement engineering. By finding through systematic literature review all the factors are briefly discussed in chapter 2. Finalized result shows that according to research questions there is a need of improvement in different factors of requirement negotiation process. The respondents are agreed that these factors can further be improved by blockchain technology. The motivation behind doing research in this field is that blockchain is continuously spreading in all fields of life because of its efficient and best features. It ensures the security of data and it is fastest technology with decentralized data. The framework implemented in this research shows that the requirements gathered will be more secured, easy to access, synchronized, validated and well prioritized. So this study shows that blockchain will solve the conflicts between stakeholders, will improve budget, time, efforts by prioritizing and validating the requirements in an effective way.

6.4. Limitation

It is proposed to be the first activity in requirement engineering process. Since it is not implemented live in any real project we are not certain of any failures and this would be the limitation of our proposal.

6.5. Future work

Since quality work is lacking in this area there is a great potential to explore this area for future research and improving the quality of software requirements.

References

[1]. A. Aurum and C. Wohlin, *Engineering and managing software requirements*. 2005.

[2]. S. Ahmad, "Negotiation in the Requirements Elicitation and Analysis Process," pp. 683–689, 2008.

[3]. S. Siddiqui, M. Beg, and S. Fatima, "Effectiveness of Requirement Prioritization Using Analytical Hierarchy Process (AHP) And Planning Game (PG): A Comparative Study," *Int. J. Comput. Sci. Inf. Technol. 2013*, vol. 4, no. 1, pp. 46–49, 2013.

[4]. M. S. Saeed, N. Sarwar, and M. Bilal, "Efficient requirement engineering for small scale project by using UML," *2016 6th Int. Conf. Innov. Comput. Technol. INTECH 2016*, pp. 662–666, 2017.

[5]. M. Q. Riaz, Fateh-Ur-Rehman, B. Maqbool, and W. H. Butt, "Customization of requirement engineering best practices for Pakistan software industry," *2018 Int. Conf. Comput. Math. Eng. Technol. Inven. Innov. Integr. Socioecon. Dev. iCoMET 2018 - Proc.*, vol. 2018-Janua, pp. 1–6, 2018.

[6]. Y. Elrakaiby, A. Ferrari, and J. Mylopoulos, "CaRE: A refinement calculus for requirements engineering based on argumentation semantics," *Proc. - 2018 IEEE 26th Int. Requir. Eng. Conf. RE 2018*, pp. 364–369, 2018.

[7]. S. Y. W. Su, C. Huang, and J. Hammer, "Replicable web-based negotiation server for e-commerce," *Proc. Hawaii Int. Conf. Syst. Sci.*, vol. 00, no. c, p. 219, 2000.

[8]. S. Yu, K. Lv, Z. Shao, Y. Guo, J. Zou, and B. Zhang, "A High Performance Blockchain Platform for Intelligent Devices," *Proc. 2018 1st IEEE Int. Conf. Hot Information-Centric Networking, HotICN 2018*, no. HotICN, pp. 260–261, 2019.

[9]. J. B. Kim and A. Segev, "A framework for dynamic eBusiness negotiation processes," *Proc. - IEEE Int. Conf. E-Commerce, CEC 2003*, pp. 84–91, 2003.

[10]. L. F. Chen, Y. S. Li, H. Wen, W. X. Lei, W. J. Hou, and J. Chen, "Block chain based secure scheme for mobile communication," *2018 IEEE Conf. Commun. Netw. Secur. CNS 2018*, 2018.

[11]. "Blockchain-CurrentAchievementsandFutureProspects-Challenges-CombiningAIBC." .

[12].   W. Haining, W. Chunyan, Z. Haoyue, X. Peiyu, and Z. Qian, "Exploration of Block chain Technology in Electric Power transaction," vol. 2, no. 201804270000819, pp. 729–733, 2019.

[13].   S. Latifi, Y. Zhang, and L. C. Cheng, "Blockchain-based real estate market: One method for applying blockchain technology in commercial real estate market," *Proc. - 2019 2nd IEEE Int. Conf. Blockchain, Blockchain 2019*, pp. 528–535, 2019.

[14].   S. Asghar and M. Umar, "Requirement engineering challenges in development of software applications and selection of customer-off-the-shelf (COTS) components," *Int. J. Softw. Eng.*, vol. 1, no. 1, pp. 32–50, 2010.

[15].   S. Sharma and S. K. Pandey, "Revisiting Requirements Elicitation Techniques," *Int. J. Comput. Appl.*, vol. 75, no. 12, pp. 35–39, 2013.

[16].   T. Xu, T. Li, L. Liu, and B. R. Bryant, "Negotiating service requirements among strategic actors," *Proc. - Int. Comput. Softw. Appl. Conf.*, pp. 31–36, 2010.

[17].   S. Linoy, H. Mahdikhani, S. Ray, R. Lu, N. Stakhanova, and A. Ghorbani, "Scalable privacy-preserving query processing over ethereum blockchain," *Proc. - 2019 2nd IEEE Int. Conf. Blockchain, Blockchain 2019*, pp. 398–404, 2019.

[18].   A. Ekblaw, A. Azaria, J. D. Halamka, and A. Lippman, "A case study for blockchain in healthcare: 'MedRec' prototype for electronic health records and medical research data," *OBD 2016 2nd Int. Conf. Open Big Data*, vol. 13, p. 13, 2016.

[19].   T. Salman, R. Jain, and L. Gupta, "A reputation management framework for knowledge-based and probabilistic blockchains," *Proc. - 2019 2nd IEEE Int. Conf. Blockchain, Blockchain 2019*, vol. 1, pp. 520–527, 2019.

[20].   S. Anwer and N. Ikram, "Goal oriented requirement engineering: A critical study of techniques," *Proc. - Asia-Pacific Softw. Eng. Conf. APSEC*, pp. 121–127, 2006.

[21].   J.-N. Mazón, J. Pardillo, and J. Trujillo, "A Model-Driven Goal-Oriented Requirement Engineering Approach for Data Warehouses," *Adv. Concept. Model. – Found. Appl.*, pp. 255–264, 2007.

[22].   J. Lei and Y. Li, "Vector-based sensitive information protecting scheme in automatic trust negotiation," *J. Networks*, vol. 9, no. 4, pp. 927–931, 2014.

[23].   B. Nuseibeh and S. M. Easterbrook, "Requirements engineering: A Roadmap," *Proc. Conf. Futur. Softw. Eng. - ICSE '00*, vol. 1, pp. 35–46, 2000.

[24]. T. Arnuphaptrairong, "Top ten lists of software project risks: Evidence from the literature survey," *IMECS 2011 - Int. MultiConference Eng. Comput. Sci. 2011*, vol. 1, pp. 732–737, 2011.

[25]. M. Agarwal and S. Goel, "Expert system and it's requirement engineering process," *Int. Conf. Recent Adv. Innov. Eng. ICRAIE 2014*, 2014.

[26]. D. Pandey, U. Suman, and A. K. Ramani, "An effective requirement engineering process model for software development and requirements management," *Proc. - 2nd Int. Conf. Adv. Recent Technol. Commun. Comput. ARTCom 2010*, pp. 287–291, 2010.

[27]. S. Mughal, A. Abbas, N. Ahmad, and S. U. Khan, "A social network based process to minimize in-group biasedness during requirement engineering," *IEEE Access*, vol. 6, pp. 66870–66885, 2018.

[28]. A. Lenz, "Decision Problems in Requirements Negotiations – Identifying the Underlying Structures," pp. 120–131, 2017.

[29]. A. L. Zanatta, "Barriers Faced by Newcomers to Software- Crowdsourcing Projects," no. April, pp. 37–43, 2017.

[30]. S. Djelassi and I. Decoopman, "Customers' participation in product development through crowdsourcing: Issues and implications," *Ind. Mark. Manag.*, vol. 42, no. 5, pp. 683–692, 2013.

[31]. A. Abdelatey, M. Elkawkagy, A. B. El-Sisi, and A. Keshk, "RGSS-negotiation: A genetic-based approach for web service security negotiation," *Proc. 2016 11th Int. Conf. Comput. Eng. Syst. ICCES 2016*, pp. 53–58, 2017.

[32]. P. Gruenbacher, "Collaborative Requirements Negotiation with EasyWinWin," pp. 954–958, 2000.

[33]. J. M. Fernandes, "Requirements Negotiation," 2016.

[34]. P. Grünbacher and N. Seyff, "7 Requirements Negotiation."

[35]. S. Malik, V. Dedeoglu, S. S. Kanhere, and R. Jurdak, "TrustChain: Trust management in blockchain and iot supported supply chains," *Proc. - 2019 2nd IEEE Int. Conf. Blockchain, Blockchain 2019*, pp. 184–193, 2019.

[36]. Z. Chen, S. Chen, H. Xu, and B. Hu, "A security authentication scheme of 5G ultra-dense network based on block chain," *IEEE Access*, vol. 6, pp. 55372–55379, 2018.

[37]. C. Catalini and J. S. Gans, "Some Simple Economics of the Blockchain," *SSRN Electron. J.*, 2016.

[38]. S. G. Sharma, L. Ahuja, and D. P. Goyal, "Building Secure Infrastructure for Cloud Computing Using Blockchain," *Proc. 2nd Int. Conf. Intell. Comput. Control Syst. ICICCS 2018*, no. Iciccs, pp. 1985–1988, 2019.

[39]. J. Brito and A. Castillo, "Summary for Policymakers," *Clim. Chang. 2013 - Phys. Sci. Basis*, vol. 29, no. 4, pp. 1–30, 2013.

[40]. G. Cui, K. Shi, Y. Qin, L. Liu, B. Qi, and B. Li, "Application of block chain in multi-level demand response reliable mechanism," *2017 3rd Int. Conf. Inf. Manag. ICIM 2017*, pp. 337–341, 2017.

[41]. M. Nakasumi, "based on Block Chain Technology," 2017.

[42]. Haber Stuart and S. W.Scott, "How to Time-Stamp a Digital Document," *J. Cryptol.*, vol. 3, no. 2, pp. 0–12, 1991.

[43]. T. W. Miller, "Do family risk factors influence Attention Deficit Hyperactivity Disorder via disruption of neurocognitive functioning?," *Diss. Abstr. Int. Sect. B Sci. Eng.*, vol. 70, no. 10-B, p. 6560, 2010.

[44]. S. Makridakis, A. Polemitis, G. Giaglis, and S. Louca, "Blockchain : Current Achievements , Future Prospects / Challenges and its Combination with AI," no. 2017, pp. 1–21, 2017.

[45]. T. Nunan, "An introduction to research paradigms in distance education," no. October 2016, 1991.

[46]. M. A. Javed, "Master thesis in software engineering and management A Rationale Focused Software Architecture Documentation method (RFSAD)," *Technology*, 2007.

[47]. B. Kitchenham, O. Pearl Brereton, D. Budgen, M. Turner, J. Bailey, and S. Linkman, "Systematic literature reviews in software engineering - A systematic literature review," *Inf. Softw. Technol.*, vol. 51, no. 1, pp. 7–15, 2009.

[48]. L. Doyle, A. M. Brady, and G. Byrne, "An overview of mixed methods research," *J. Res. Nurs.*, vol. 14, no. 2, pp. 175–185, 2009.

[49]. A. K. Bekhet and J. A. Zauszniewski, "Methodological triangulation: An approach to understanding data," *Nurse Res.*, vol. 20, no. 2, pp. 40–43, 2012.

[50]. D. E. Perry, S. E. Sim, and S. M. Easterbrook, "Case studies for software engineers," *Proc. - Int. Conf. Softw. Eng.*, vol. 26, pp. 736–738, 2004.

[51]. P. S. Kidd and M. B. Parshall, "Getting the focus and the group: Enhancing analytical rigor in focus group research," *Qual. Health Res.*, vol. 10, no. 3, pp. 293–308, 2000.

[52]. D. Carson, A. Gilmore, C. Perry, and K. Gronhaug, "Focus Group Interviewing," *Qual. Mark. Res.*, no. October, pp. 113–131, 2011.

[53]. P. Lunt and S. Livingstone, "Rethinking the Focus Group in Media and Communications Research," *J. Commun.*, vol. 46, no. 2, pp. 79–98, 1996.

[54]. D. M. Running, J. B. Ligon, and I. Miskioglu, "DELETE from the SAGE Social Science Collections . All Rights Reserved .," *J. Compos. Mater.*, vol. 33, no. 10, pp. 928–940, 1999.

[55]. K. Institutet, "transcultural psychiatry Psychiatry: Reflections on Research Experiences," vol. 39, no. December, pp. 484–500, 2002.

[56]. E. Folch-Lyon and J. F. Trost, "Conducting Focus Group Sessions," *Stud. Fam. Plann.*, vol. 12, no. 12, p. 443, 1981.

[57]. S. Linoy, H. Mahdikhani, S. Ray, R. Lu, N. Stakhanova, and A. Ghorbani, "Scalable Privacy-Preserving Query Processing over Ethereum Blockchain," in *2019 IEEE International Conference on Blockchain (Blockchain)*, Atlanta, GA, USA, Jul. 2019, pp. 398–404, doi: 10.1109/Blockchain.2019.00061.

[58]. C. Catalini and J. S. Gans, "Some Simple Economics of the Blockchain," *SSRN Electron. J.*, 2016, doi: 10.2139/ssrn.2874598.

[59]. L. Wan, D. Eyers, and H. Zhang, "Evaluating the Impact of Network Latency on the Safety of Blockchain Transactions," in *2019 IEEE International Conference on Blockchain (Blockchain)*, Atlanta, GA, USA, Jul. 2019, pp. 194–201, doi: 10.1109/Blockchain.2019.00033.

[60]. R. Wang, J. He, C. Liu, Q. Li, W.-T. Tsai, and E. Deng, "A Privacy-Aware PKI System Based on Permissioned Blockchains," in *2018 IEEE 9th International Conference on Software Engineering and Service Science (ICSESS)*, Beijing, China, Nov. 2018, pp. 928–931, doi: 10.1109/ICSESS.2018.8663738.

[61]. T. Xu, T. Li, L. Liu, and B. R. Bryant, "Negotiating Service Requirements among Strategic Actors," in *2010 IEEE 34th Annual Computer Software and Applications Conference Workshops*, Seoul, Korea (South), Jul. 2010, pp. 31–36, doi: 10.1109/COMPSACW.2010.16.

[62]. T. Salman, R. Jain, and L. Gupta, "A Reputation Management Framework for Knowledge-Based and Probabilistic Blockchains," in *2019 IEEE International*

Conference on Blockchain (Blockchain), Atlanta, GA, USA, Jul. 2019, pp. 520–527, doi: 10.1109/Blockchain.2019.00078.

[63]. S. G. Sharma, L. Ahuja, and D. P. Goyal, "Building Secure Infrastructure for Cloud Computing Using Blockchain," *Proc. 2nd Int. Conf. Intell. Comput. Control Syst. ICICCS 2018*, no. Iciccs, pp. 1985–1988, 2019, doi: 10.1109/ICCONS.2018.8663145.

[64]. J. Brito and A. Castillo, "Summary for Policymakers," *Clim. Change 2013 - Phys. Sci. Basis*, vol. 29, no. 4, pp. 1–30, 2013, doi: 10.1017/CBO9781107415324.004.

[65]. G. Cui, K. Shi, Y. Qin, L. Liu, B. Qi, and B. Li, "Application of block chain in multi-level demand response reliable mechanism," *2017 3rd Int. Conf. Inf. Manag. ICIM 2017*, pp. 337–341, 2017, doi: 10.1109/INFOMAN.2017.7950404.

[66]. H. Guo, W. Li, M. Nejad, and C.-C. Shen, "Access Control for Electronic Health Records with Hybrid Blockchain-Edge Architecture," in *2019 IEEE International Conference on Blockchain (Blockchain)*, Atlanta, GA, USA, Jul. 2019, pp. 44–51, doi: 10.1109/Blockchain.2019.00015.

[67]. M. Nakasumi, "based on Block Chain Technology," 2017, doi: 10.1109/CBI.2017.56.

[68]. X. Yang, Y. Chen, and X. Chen, "Effective Scheme against 51% Attack on Proof-of-Work Blockchain with History Weighted Information," in *2019 IEEE International Conference on Blockchain (Blockchain)*, Atlanta, GA, USA, Jul. 2019, pp. 261–265, doi: 10.1109/Blockchain.2019.00041.

[69]. S. Li, H. Xiao, H. Wang, T. Wang, J. Qiao, and S. Liu, "Blockchain Dividing Based on Node Community Clustering in Intelligent Manufacturing CPS," in *2019 IEEE International Conference on Blockchain (Blockchain)*, Atlanta, GA, USA, Jul. 2019, pp. 124–131, doi: 10.1109/Blockchain.2019.00025.

[70]. S. Yang, Z. Chen, L. Cui, M. Xu, Z. Ming, and K. Xu, "CoDAG: An Efficient and Compacted DAG-Based Blockchain Protocol," in *2019 IEEE International Conference on Blockchain (Blockchain)*, Atlanta, GA, USA, Jul. 2019, pp. 314–318, doi: 10.1109/Blockchain.2019.00049.

[71]. Haber Stuart and S. W.Scott, "How to Time-Stamp a Digital Document," *J. Cryptol.*, vol. 3, no. 2, pp. 0–12, 1991.

[72]. A. Davenport and S. Shetty, "Air Gapped Wallet Schemes and Private Key Leakage in Permissioned Blockchain Platforms," in *2019 IEEE International Conference on Blockchain (Blockchain)*, Atlanta, GA, USA, Jul. 2019, pp. 541–545, doi: 10.1109/Blockchain.2019.00004.

[73]. R. Peng, Q. Ye, and M. Ye, "A Requirements Maturity Measurement Approach Based on SKLSEWiki," in *2010 IEEE 34th Annual Computer Software and Applications Conference Workshops*, Seoul, Korea (South), Jul. 2010, pp. 251–254, doi: 10.1109/COMPSACW.2010.51.

[74]. Hoh In, D. Olson, and T. Rodgers, "A requirements negotiation model based on multi-criteria analysis," in *Proceedings Fifth IEEE International Symposium on Requirements Engineering*, Toronto, Ont., Canada, 2000, pp. 312–313, doi: 10.1109/ISRE.2001.948600.

[75]. E. Dubois, K. Kritikos, and S. Kubicki, "An Automatic Requirements Negotiation Approach for Business Services," in *2011 IEEE Ninth European Conference on Web Services*, Lugano, Switzerland, Sep. 2011, pp. 133–140, doi: 10.1109/ECOWS.2011.19.

[76]. T. W. Miller, "Do family risk factors influence Attention Deficit Hyperactivity Disorder via disruption of neurocognitive functioning?," *Diss. Abstr. Int. Sect. B Sci. Eng.*, vol. 70, no. 10-B, p. 6560, 2010, doi: 10.1016/bs.adcom.2018.03.006.

[77]. Y. He, M. Zhu, and C. Zheng, "An Efficient and Minimum Sensitivity Cost Negotiation Strategy in Automated Trust Negotiation," in *2008 International Conference on Computer Science and Software Engineering*, Wuhan, China, 2008, pp. 182–185, doi: 10.1109/CSSE.2008.867.

[78]. S. Makridakis, A. Polemitis, G. Giaglis, and S. Louca, "Blockchain : Current Achievements, Future Prospects / Challenges and its Combination with AI," no. 2017, pp. 1–21, 2017.

[79]. FQ Khan, S Musa, G Tsaramirsis, ST Bakhsh, "A study: selection of model metamodel and SPL tools for the verification of software product lines" International Journal of Information Technology 9 (4), 353-362.

[80]. S Khan, TB Sheikh, "A Study on the Role of Facebook in E-Learning", International Journal of Education and Management Engineering 5 (5), 1, 2015.

[81]. M. Asif, I. Ali, M. S. A. Malik, M. H. Chaudary, S. Tayyaba and M. T. Mahmood, "Annotation of Software Requirements Specification (SRS), Extractions of Nonfunctional Requirements, and Measurement of Their Tradeoff," in IEEE Access, vol. 7, pp. 36164-36176, 2019, doi: 10.1109/ACCESS.2019.2903133.

[82]. Khan, F. A., Asif, M., Ahmad, A., Alharbi, M., &Aljuaid, H. (2020). Blockchain technology, improvement suggestions, security challenges on smart grid and its

application in healthcare for sustainable development. Sustainable Cities and Society, 55, 102018.

[83]. Khan, F. A., Jamjoom, M., Ahmad, A., & Asif, M. (2019). An analytic study of architecture, security, privacy, query processing, and performance evaluation of database-as-a-service. *Transactions on Emerging Telecommunications Technologies*, e3814.

[84]. Basit Shahzad, Waqar Aslam, Abdullah Tahir, Anam Hameed, Nosheen Younas, Aasma Batool. (2020). An Investigation of Challenges and their Resolution in Crowdsourced Team Formation.

[85]. Abdul Hafeez Muhammad, Ansar Siddique, Ahmed E Youssef, Kashif Saleem, Basit Shahzad, Adnan Akram, Al-Batool Saleh Al-Thnian. (2020). A Hierarchical Model to Evaluate the Quality of Web-Based E-Learning Systems.

[86]. Shahzad, Basit, and Jon Crowcroft. "Trustworthy Electronic Voting Using Adjusted Blockchain Technology." *IEEE Access*, vol. 7, 2019, pp. 24477–24488., doi:10.1109/access.2019.2895670.

[87]. Al-Muhtadi, Jalal, et al. "Cybersecurity and Privacy Issues for Socially Integrated Mobile Healthcare Applications Operating in a Multi-Cloud Environment." *Health Informatics Journal*, vol. 25, no. 2, 2017, pp. 315–329., doi:10.1177/1460458217706184.

[88]. M. Samiullah *et al.*, basit shahzad"An Image Encryption Scheme Based on DNA Computing and Multiple Chaotic Systems," *IEEE Access*, vol. 8, pp. 25650–25663, 2020.

[89]. H. Muhammad *et al.*, basit shahzad "A Hierarchical Model to Evaluate the Quality of Web-Based E-Learning Systems," *Sustainability*, vol. 12, no. 10, p. 4071, May 2020.

[90]. S. Tahir, B. Shahzad, S. T. Bakhsh, and M. Basheri, "Developing Relationship Among Risk Factors and Project Factors for Large Scale Healthcare Applications," *Journal of Medical Imaging and Health Informatics*, vol. 10, no. 10, pp. 2439–2445, Oct. 2020.

[91]. F. Javeed, A. Siddique, A. Munir, B. Shehzad, and M. I. U. Lali, "Discovering software developer's coding expertise through deep learning," *IET Software*, vol. 14, no. 3, pp. 213–220, Jun. 2020.

[92]. M. S. Nawaz, M. Sun, B. Shahzad, M. I. U. Lali, T. Umer, and S. Wan, "Quality of service in IoT protocol as designs and its verification in PVS," *Transactions on Emerging Telecommunications Technologies*, Oct. 2019.

[93]. B. Shahzad and K. Saleem, "A Special Section on Innovations in Large Scale Healthcare Application Development," *Journal of Medical Imaging and Health Informatics*, vol. 10, no. 10, pp. 2342–2344, Oct. 2020.

[94]. basitshahzad and J. Iqbal, "Software Risk Management–Prioritization of frequently occurring Risk in Software Development Phases. Using Relative Impact Risk Model," *2nd International Conference on Information and Communication Technology (ICICT2007)*, pp. 16–17, Dec. 2007.

[95]. S. Yaseen*et al.*, "Improved Generalization for Secure Data Publishing," *IEEE Access*, vol. 6, pp. 27156–27165, 2018.

Appendix A

Questionnaire

1. For each statement, please indicate your answer using the following scale:

Strongly Agree	Strongly Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

	Challenges in requirement negotiation	5	4	3	2	1
1.	Do weak algorithms in requirement negotiation produces low quality software projects?					
2.	There are many algorithms but still conflicts between stakeholders make decision making complex.					
3.	Requirement negotiation process lacks the quality communication.					
4.	Requirement negotiation in crowds sourcing is time consuming.					
5.	Requirements are less synchronized.					

6.	Requirement negotiation through social media mostly leads to gather unauthorized data.					
7.	Requirement negotiation is complex process.					
8.	Requirement negotiation is time consuming process.					
9.	It is necessary to validate the requirements through an efficient technology.					

10. Which technology is best?

☐   Artificial Intelligence

☐   Blockchain Technology

☐   Machine Learning

11. What is your first reaction to the technology?

☐   Very positive

☐   Positive

☐   Neutral

☐   Negative

☐   Very negative

12. How would you rate technology?

☐   Very high quality

☐   High quality

☐   Neither high nor low quality

☐   Low quality

☐   Very Low quality

	Blockchain technology	5	4	3	2	1
13. .	Blockchain technology can improve the quality of requirement negotiation process.					
14.	Blockchain can solve the conflicts between stakeholders because of its effective frameworks.					
15.	Blockchain can improve the quality of communication because of its decentralized and direct connections.					
16.	Blockchain can improve requirement negotiation through crowd sorucing.					
17.	Can blockchain based framework gather synchronized requirements?					
18.	Do blockchain help to gather authorized data from social media?					
19.	Can requirement negotiation process be improved by blockchain?					

20.	Do blockchain help to reduce time consumption during requirement negotiation process?					
21.	Can blockchain based technology improves the speed of requirement negotiation process?					
22.	Can blockchain based platform easily be implemented in requirement negotiation?					