IDENTIFICATION AND MITIGATION OF CHALLENGES IN MACROTASK CROWDSOURCING

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Identification And Mitigation of Challenges In Macrotask Crowdsourcing

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Candidate of **Master of Science in Software Engineering (MSSE)** at the National University of Modern Languages do hereby declare that the thesis **Identification and Mitigation of Challenges in Macrotask Crowdsourcing** submitted by me in partial fulfillment of MSSE degree, is my original work, and has not been submitted or published earlier. I also solemnly declare that it shall not, in future, be submitted by me for obtaining any other degree from this or any other university or institution. I also understand that if evidence of plagiarism is found in my thesis/dissertation at any stage, even after the award of a degree, the work may be cancelled, and the degree revoked.

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ABSTRACT

Identification and Mitigation of Challenges in Macrotask Crowdsourcing

Crowdsourcing has become an evolution in which tasks are outsourced by open call format to large numbers of people to utilize collective intelligence. Macro-tasking crowdsourcing is used to resolve various complexities with different degrees of disintegration, assumes different expert level of knowledge in one or even more fields, and integrates adaptable Processes for work management involving crowd involvement. Crowdsourcing should identify macro-tasking for tackling more complicated problems. Macro tasks could be defined as complicated multitasking that is often decomposable to micro tasks, though not always. Macrotask crowdsourcing has many advantages in every step of the software development life cycle due to its diversity of crowds, faster problem solving and significant cost savings but at the same time, there are many risks involved. Which affects the success of crowdsourcing in software development life cycle. In this search first of all we will identify all the challenges macrotask crowdsourcing through systematic literature review from the literature and then we will propose the mitigation plan to mitigate the challenges that causes the harm to the macrotask crowdsourcing system and approaches to prevent these challenges achieve goals of software macrotask crowdsourcing. We will use the mixed methodology of systematic literature review, qualitative and quantitative analysis to get our results. Systematic literature review will be used to identify the challenges of macrotask crowdsourcing and then we will confirm it from industry by doing the survey and then we will do the focus group to verify it from the experts. Our results will identify the challenges that causes the harm to software crowdsourcing and the mitigation plan to remove them to achieve the maximum results for macrotask crowdsourcing. Our research will cover the gap of identification of challenges of macrotask crowdsourcing and its mitigation plan to help all the stakeholders in the industry to achieve maximum results in the macrotask crowdsourcing projects. In the future phase we will implement these mitigation strategies in the industry.

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DEDICATION

This thesis work is dedicated to my parents and my teachers throughout my education career who have not only loved me unconditionally but whose good examples have taught me to work hard for the things that I aspire to achieve.

CHAPTER 1

INTRODUCTION

1.1 Overview

Software engineering is the process of analyzing user demands and developing, producing, and testing end-user programs to meet those needs using software programming languages. Global Individuals escalate action in software development since it is a learning process. GSD brings together experts from many backgrounds and regions to collaborate on platforms and produce effective applications. Individuals must interact, communicate, and coordinate their efforts during such events, necessitating the usage of learning management software. In fact, without information management, it is unlikely that small and stable connections can be formed where workers are within an arm's reach of one another [1].

Crowdsourcing is a new paradigm in which work are outsourced to big groups of individuals via an open call style in order to tap into collective wisdom. J. Howe and M. Robinson created the term, which means "outsourcing labor to undefined, networked persons in the form of an open call" [2]. There are four pillars to any crowdsourcing activity, two of which are related to the human component [3]. The audience and the crowdsourcer are the two pillars. The task and the crowdsourced platform are the other two.

i.   The crowd in an activity to provide information for demand engineers can be mapped to the users and other players.
ii. The Crowd sourcers can be mapped to the requirements of engineers in a crowdsourcing activity.

iii.   Task: is what needs to be performed or solved.

iv.   The crowdsourced platform is where all these activities happen.

Crowdsourcing employs a variety of business models, including a competition model, an auction-based strategy, and a collaborative method. Topcoder, Appi Shop, MechnicalTurk, CloudCrowd, and CrowdFlower are examples of crowdsourcing platforms. [4]. Crowdsourcing can be applied to a variety of tasks, including requirements engineering. Requirements engineering is a subset of software engineering that defines the system's functions and restrictions [5]. Instead of microtasks that are easier to complete, Cheng et al. have defined macro tasks as massive work that take relatively more time to complete e.g. transcription of a speech [6]. Macrotask crowdsourcing needs a variety of skills in the 21st century, profits from employee communication, cooperation, training and integrates Adaptable processes of work management with staff members.

Micro-tasks are simple, standalone tasks that do not need coordination between workplaces. For instance, Alter a sentence to a different language. Crowdsourcing should consider macro-tasking for tackling complicated problems issues. Macrotasking may be mentioned as complex crowd work, which is not really exchangeable to micro tasks at times [7]. For instance, To create a comprehensive tool that translates phrases into other languages automatically. Macro tasks crowdsourcing has many advantages in terms every step of software development life cycle due to its diversity of crowd, broader view of system, faster problem solving, significant cost saving and a rich source of data but at the same time there are notable risk involved in this process like communication gap, confidentially, popularity misleads, uncontrolled resources, cost estimation etc. which affects the success of crowdsourcing in SDLC. In our studies we will analyze and mitigate the risks that causes the harm to the system and prevent it to achieve the maximum goals of crowdsourcing.

Our study consists of systematic literature study as we will identifying the challenges of macro task crowdsourcing from the literature and then we will perform a survey from the industry on the basis of challenges we find from systematic literature review. Then we will evaluate those challenges from the industry by conducting survey, focus group and expert review.

1.2   Literature Review

Jeff Howe coined the term "crowdsourcing" [8], who described it as "the act of a firm or institution taking a job once managed by personnel and outsourcing it to an undefined (and generally huge) network of people in the form of an open call." Nitasha Hasteer et al. [9] discusses the profits and the challenges that are being faced in crowdsourcing software development. They looked into current case studies that revealed the benefits and drawbacks of crowdsourcing software development. According to them, the benefits of crowdsourcing are increasing in terms of software schedule, cost, and quality due to its diversity and flexibility, while the worries about cost, quality, schedule, and validation are increasing due to limited visibility and control over job processes.

Alpana Dubey et al. [11] discusses the dynamics of software development crowdsourcing. They investigated the historical data and results using the crowdsourcing techniques. They have analyzed the historical data from the big platforms like Upwork, According to top coder, the platforms do display some regularity in task completion. Susan Standing et al. [12] considers the ethical concerns linked to knowledge exchange and relational characteristics of crowdsourcing. They introduced a system using questionnaires to direct the ethical adoption and use of crowdsourcing by organizations, members, and communities. The five elements of the process are: consideration of ethical issues, acquiring different perspectives, exploring measures, taking a decision and reviewing, reflecting and making changes. Crowdsourcing acknowledges consumer empowerment.

Mahmood Hosseini et al. [13] explained crowdsourcing in terms of requirements engineering to guarantee the correctness and maximize the efficiency. They reported that the requirement gathering through crowdsourcing is more effective as the diversity of the crowd plays a vital role in gathering the requirement [15]. Microtasks are nonpartisan tasks that need not be coordinated between people. For example, altering a sentence into another language. Crowdsourcing should define macro tasks to deal with more complicated situations. For example, making a whole tool which automatically interpret the sentences into another languages [16]. M. Voukic [17] explained the crowdsourcing for enterprises. Crowdsourcing is increasingly being used by businesses to reach out to scalable workforces via the internet. Cloud computing, on the other hand, has emerged as a new paradigm for providing computational

services that utilizes a shared infrastructure to seamlessly combine the physical and digital online worlds. The goal of this study is to illustrate a crowdsourcing scenario in the software development industry so that the prerequisites for installing a general-purpose crowdsourcing service in the Cloud may be determined. It divides crowdsourcing platforms into categories and compares a number of existing systems to the identified topographies.

Yaroon Singer et al. [18] discussed pricing mechanisms for crowdsourcing markets. In this study, we present a methodology for developing crowdsourcing market mechanisms with proved promises. To show how successful this framework is, we built a platform that allows users to apply price methods to markets like Mechanical Turk. The platform allows us to show that the processes described here work in practice, as well as give experimental proof of wearers' strategic behavior in the lack of sufficient incentive schemes [19].

In macrotask crowdsourcing, Lion P. [16] discusses crowdsourcing coordination. The goal of this study is to better comprehend crowd collaboration in order to tackle complex macro-tasks. Crowd-sourcing is typically used to do simple micro-tasks, despite its ability to address complex problems. The goal of this chapter is to obtain a better knowledge of crowd coordination so that advanced macro-tasking may be managed. To do this, we have defined three objectives. The study examines existing crowd coordinating approaches as well as popular crowd coordination theories in the disciplines of CSCW and HCI. Finally, the chapter identifies research gaps and suggests a research agenda aimed at better understanding crowd coordination, which is necessary for performing complicated macro-tasks.

So, the literature review shows that there is a need to improve the macro tasking process in crowd sourcing. This issue can be resolved by following software project management best practices. Software project management guidelines will be introduced in this research to solve the challenges in macro task crowdsourcing. The challenges in macrotask crowd sourcing are communication, collaboration, culture gap, management issues, cost estimation and requirement documentation. Macrotask crowdsourcing can be improved by applying SPM guidelines. By this the communication will be improved between stakeholders and they will be able to understand each other perfectly. Their collaboration will be improved, and they will complete projects under specific budget and time. The quality of the produced project will also be improved, and the customer need will also be fulfilled.

1.3   Problem Statement

There are many advantages of macrotask crowdsourcing in terms of every step of software development life cycle due to its diversity of crowd, broader view of system, faster problem solving, significant cost saving and a rich source of data but at the same time there are great risks involved in this process like communication gap [21], requirements documentation [22], collaboration, communication, coordination [16], technical gap, cultural gap [20], management gap [23] and cost estimation [18]. which affects the success of macrotask crowdsourcing in software development life cycle. These challenges needs to be addressed for further improvement.

1.4   Research Questions

We have two Questions regarding research that are as follows:

RQ1: What are the challenges of macrotask crowdsourcing?
RQ2: How to mitigate those challenges to achieve the maximum results of macrotask crowdsourcing?

1.5   Aim of the Research

Our research will cover the gap of identification of challenges of macrotask crowdsourcing and its mitigation plan to help all the stakeholders in the industry to achieve maximum results in the macrotask crowdsourcing projects.

1.6   Research Objectives

These are the aims of our research.

i.   To identify the factors effecting the success of software macrotask crowdsourcing software projects.

ii.   To identify the mitigation plan to remove these factors to improve the success of the macrotask crowdsourcing projects.

1.7   Research Methodology

We will use the mixed the methodology for conducting the results. SLR uses systematic techniques to assess secondary data, analyze research studies critically and synthesise results qualitatively or quantitatively. These are intended to provide a full, comprehensive summary of current evidence applicable to a research issue. A SLR [24] includes various separate activities. In software engineering, SLR is becoming quite common. A SLR is the method that all accessible research related to a selected research or subject area can be assessed and understand. In our attempt to review, Kitchenham's work will be followed since it provides the most thorough framework for doing SLR in the field of software engineering. The three aspects of our SLR were review planning, review execution, and results reporting. For first question which is, what are the challenges of macrotask crowdsourcing, we will find the hard tasks of macrotask crowdsourcing through systematic literature review and then we will evaluate those tasks through kitchenham's survey guidelines. Then we will verify those results by focus group, after getting both results of survey and focus group a triangulation process will give final results. On

the bases of these final results mitigation strategies will be proposed. These proposed strategies will be further validated by conducting expert review fig 1.1.
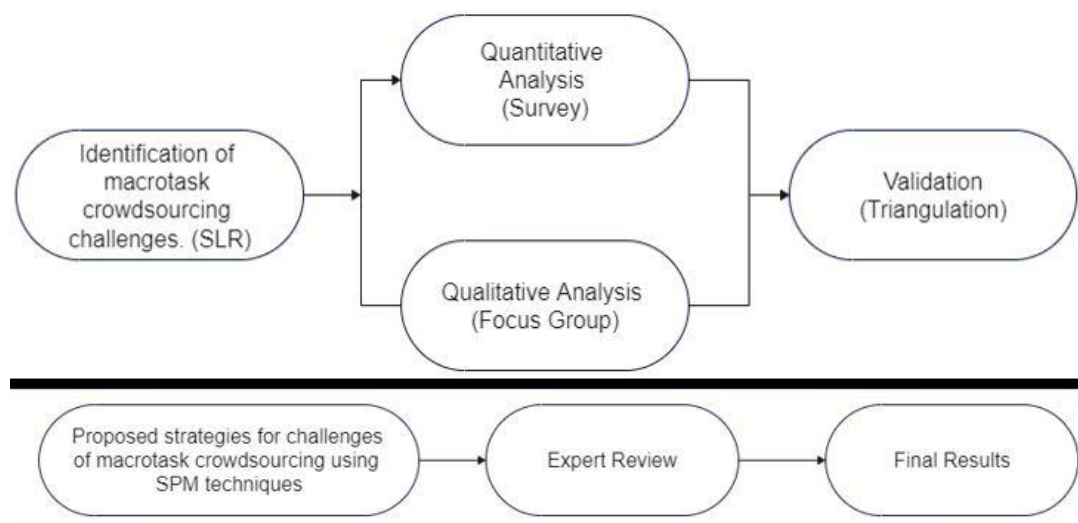
Fig 1.1: Summary of Research Methodology

For the second question which is figuring out how to deal with these tasks to achieve the maximum results of macrotask crowdsourcing, we will propose mitigation strategies from the software project management and then we will do an expert review to validate these proposed mitigation strategies to achieve the maximum results of macrotask crowdsourcing. After getting both results of survey and focus group a triangulation process will give final results. On the bases of these final results mitigation strategies will be proposed. These proposed strategies will be further validated by conducting expert review.

1.8   Thesis Organization

The rest of thesis is organized as: the literature review is presented in Chapter 2 and includes all of the details as well as relevant studies. This chapter provides bibliometric analysis, which includes all relevant study details. This will aid in the development of the thesis. The thesis technique will be presented in Chapter 3. This section describes qualitative and quantitative research and discusses how mixed method research was conducted. To conduct quantitative analysis, survey design principles were followed. All survey steps are detailed, as well as the survey design guidelines. Because a focus group is used to perform qualitative research, all of the elements of the process are briefly covered in this section. In Chapter 4, all

of the findings from the survey and focus groups are combined. These findings are then scrutinized one by one. The results will be analyzed in Chapter 5. To determine the most justifiable result, a comparison of two procedures is performed. Following that, case studies are included. The sixth chapter will include a summary of contributions as well as a discussion of the overarching thesis. It also contains limitations for future work.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview

Jeff Howe [8] a contributing editor for Wired magazine coined the term "crowdsourcing" in 2006, defining it as "simply defined, crowdsourcing represents the act of a company or organization outsourcing a purpose once performed by employees to an undefined (and generally large) network of people in the form of an open call." Mahmood Hosseini, Keith Phalp, and others defined the four pillars of crowdsourcing [3]. The crowd refers to the people who take part in the crowdsourcing activity. They have five distinct characteristics: diversity, unknown-ness, largeness, undefined-ness, and sustainability. A crowdsourcing organization, a non-profit organization , or a firm that uses the power of the crowd to complete a task is referred to as a crowdsourcing organization . Incentive provision, open call, ethical provision, and privacy provision are the four distinct elements [25].

Razieh Sareem et al. [27] is to address task failures in crowdsourcing and purposed a simulation model for it. A hybrid simulation approach is presented in this study to address the risk of task failure in competitive crowdsourcing platforms.

2.1.1 Micro Level

Crowdsourced tasks incorporate elements of online and unfamiliar workers. In order to simulate the conduct of crowd workers individually, the Apply Agent (AB) method allows observe the diversity of characteristics. Crowdworkers are presented as agents with either one of the these features, an autonomous agent who can function autonomously and manage their behaviors in the environment, can be identified by a set of rules that guide their actions, located workers who work and interact in same surroundings and flexible agent who might adapt its behavior patterns [16].

2.1.2 Meso Level

Tasks are described in this model like a set of discrete beginning and ending events. The overall objective and project success are accomplished in a sequence of tasks. Time from start to finish is the duration of the task and an agent is expected to execute the task. can be distinguished by a system of rules that govern their behaviors, an autonomous agent capable of working autonomously and regulating their actions in the environment.

2.1.3 Macro Level

The task is managed sequentially for each agent's behavior and discrete occurrences in an agent-based paradigm. The dynamic system shows interactions between system parameters and platform feedback. This model comprises 8 factors such as decision of the agent, task, quality of presentations, the various crowdsourced markets available, job similarity, profile of worker and skill set. The SD model illustrates the causal loops between the various platform levels [16].

2.1.4 Overview of Hybrid Simulation Model

At the micro level, the agent-based simulation works, Meso level task completion defines the systematic way to complete all the tasks from task arrived in task completed and at Macro Level Systematic Dynamic approach is used. Shruti Sharma et al. [15] report on the main research topics in this emerging software development paradigm that includes crowdsourcing. Crowdsourcing implies task decomposition and a greater range of participants, resulting in more effective and diverse solutions. The crowd who actively participates in this activity is invited to an open call.

Stake-Source Platforms Covered for CRE: It is an online platform for the generation of requirements [16]. It aims to suggest assisting other shareholders in the process of obtaining requirements. Chong Wang et al. [29] described The feedback on software systems produced over a period of time by a wide network of unknown users is a skilled type of crowdsourcing. Previous research has stipulated customer feedback as the identifier to new and modified requirements for RE practices and software features that should be added, enhanced or neglected.

To understand the reason for shifting from a micro task to an overview, one should realize first the problems that would and would not be solved by every crowdsourcing model. The issue of knowledge can be defined by three characteristics: structure, decay and complexity [30]. Complexity represents the number and value of the knowledge areas relevant to the issues. Simple problems often contain little area of knowledge with a low level of interdependence in the domain. More complicated problems involve a considerable number of disciplines of knowledge that have a prominent level of domain interaction. Decomposability measures the possibility of dividing the problem into micro and the grain that division may achieve. Analyzed problems might be divided into sub-problems based on different knowledge sets, which could then be addressed automatically with little formal declaration or coordination between analytical people.

We conclude that all macrotasks are complicated to construct this figure. Afterwards, we have a cartesian area with structural and decomposable dimensions. Main kinds of macro tasks are characterized by this space, modular, interlaced, wicked and container.

Structure

Interlaced   Modular

                                    Decomposability

Wicked   Container
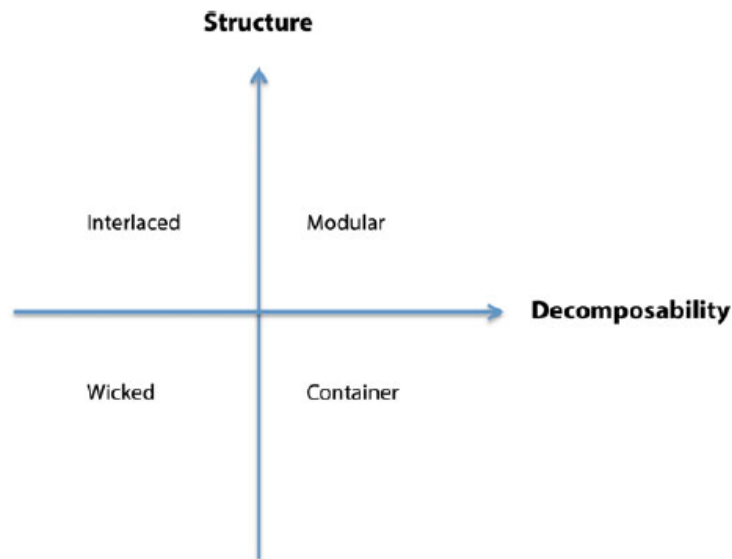
Figure 2. 1: The Macrotask Dimension

But at the other hand, non-decomposable problems cannot be subdivided into discrete subproblems because their information domains are excessively interdependent fig 2.1. In the case, this necessitates a thorough strategy that allows issue solvers to keep track of the overall problem context. The extent to which all knowledge disciplines linked to the issue can be governed is referred to as structure, and the links between the domains identified. The best problems are a clear set of relevant areas of knowledge.

2.2 Types of Macrotasking

There are four types of macro tasking which includes modular, interlaced, wicked and container. These types of macrotask crowdsourcing are defined as below:

2.2.1 Modular Macrotask

Modular macro tasks are designed to solve decomposable and well-structured problems. They are mostly complicated problems that focus crowd-sourcing literature and applications. Thus, since the "divide and conquer" approach can tackle such issues. First, the problem is reduced to narrower, separate working units at the level of microtasks. Then, in parallel, several workers will be assigned the different microtasks, and by combining smaller individual subtasks they are recomposed to the end outcome.

Modular macrotasks include examples: classification formation [31] , itinerary planning [32], editing and correcting a document [33] or amassing Conversions to a greater corpus in numerous words or sentences [34].

2.2.2 Interlaced Macrotask

Interlaced macrotasks are designed to address issues that are well structured but not degradable. These issues often start at the start of creative projects for all purposes and most of the time, just handled manually, though the remaining part of the project could be disrupted and eventually crowdsourced [35]. Continuity of useful action can be used to solved problems. Interlaced macrotasks example: To define or to express the R&D approach to the investigated methodology.

2.2.3 Wicked Macrotask

"Wicked challenges" or "holy grail" problems are the third level of macrotask difficulty. These are unstructured tasks in which the connections between necessary knowledge domains (or even the actual requisite knowledge domains) are hazy, and the supplies are insufficient, conflicting, and, in some situations, continually changing.

Wicked problems are frequently addressed in a crowdsourcing setting through innovation idea competitions [36], in which the goal is to collect as many ideas as possible in order to identify the rare breakthrough ideas, and concept generation is slightly iterative. There has been little research on how to use crowdsourcing to process and deal with wicked situations. End-to-end innovation production is one of the Type 3 macrotasks.

2.2.4 Container Macrotask

The fourth macrotask type is intended to evaluate situations that are both disorganized and easily analyzed. Despite the fact that such difficulties are not specifically addressed in the literature, they can be abstractly recognized using organizational research's structure/decomposability matrix. These are issues for which the requisite competence cannot be determined a priori, but which can be determined with the assistance of an expert or team of experts. The organization of a team of crowd workers, for example, is an issue in the context of crowdsourcing.

This phenomenon has been discussed in recent literature, with reports stating that high-reputation Complex tasks are delegated by crowdworkers [37]. They also explain tasks on a regular basis and give their representatives training (in the form of instructions) on how to complete the (part of) complex work. Deconstructing and delegating actions based on knowledge and understanding the ill-structured problem could be a precursor to more complex processes required to manage these jobs. Future research will be required to go deeper into such challenges and discover whether crowdsourcing methods may be used to address them.

2.3 Potential Benefits for Macro-tasking

Absolute communication provides for wider tolerances in crowd employee coordination. The expense of explicit communication is lowered as a whole. You may also use it to set and assign tasks.

2.4 Potential Drawbacks for Macro-tasking

Crowds require a common working history or a way to convey who knows who in a crowd. Stages can be used to communicate information about what is happening during a gathering. Existing crowd workers, on the other hand, may struggle to keep track of who knows what in terms of affection for new and incoming members.

2.5 SLR Protocols

Systematic literature review is conducted by following Kitchenham guidelines [24]. After the SLR was initiated in 2004, software engineering is turn out to be quite common in order to explore more about this field. A SLR is "a method of enhancing and interpreting all of the research done in conjunction with a specific investigation, topic or phenomenon of interest."

First of all, a protocol to evaluate this SLR is designed. Fig 2.2 illustrates the examination protocol. In the review protocol, there are seven research phases.:

- Motivation for research and the framing of research questions
- Structure of the search string
- Electronic research database selection
- Putting together a collection of research articles
- Inclusion and exclusion criteria
- Identifying and deciding on quality assessment criteria
- Information synthesis

The research interest is determined by various research problems described in the literature and related to the various priority aspects and techniques.
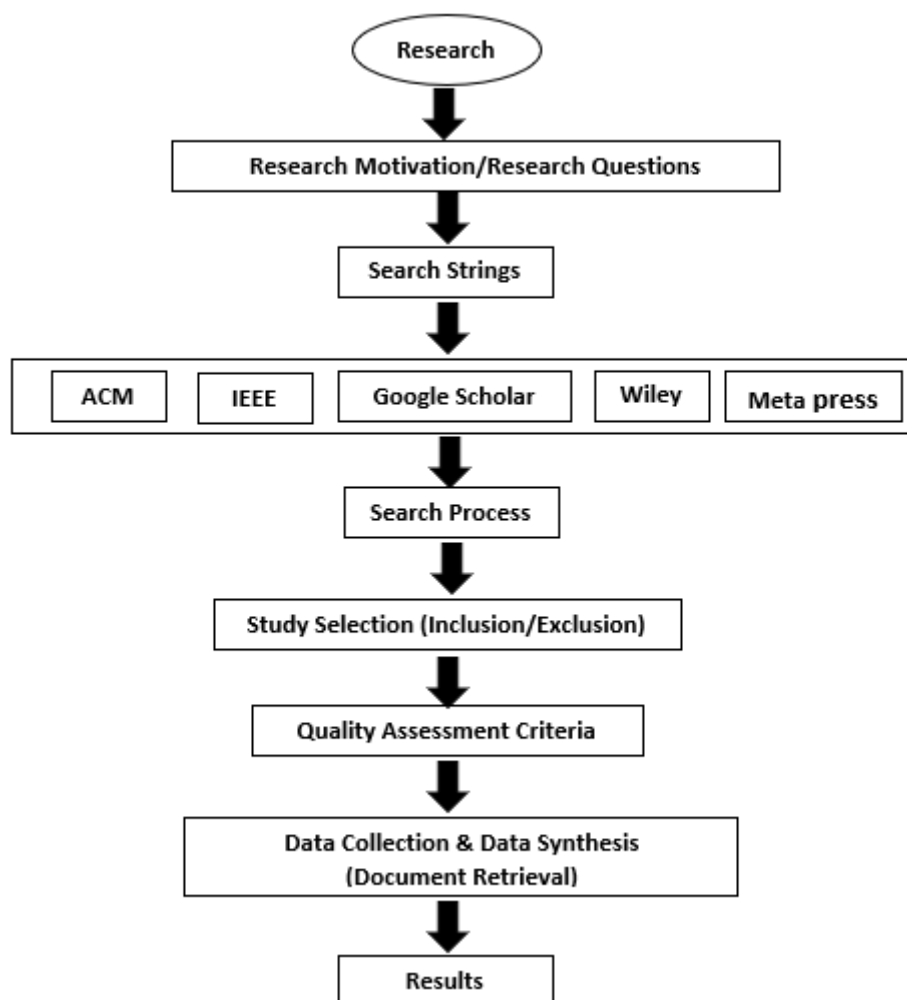
Figure 2. 2*:* Protocol of SLR

The study objectives aid in the definition of the research's boundaries as well as the discovery of published research in a defined topic. The keywords are associated with crucial technical terminology gleaned from recent research. The research were discovered using a variety of electronic databases. Figure 1, 33 studies on the concentrated problem area were investigated.

To search for research papers, however, seven electronic databases are used. ACM, IEEE Xplore digital library, and Google search were the electronic databases employed. Several

research papers were completed during the search process; nevertheless, the associated studies required to be sorted out. The research process is streamlined to acquire the most supporting publications, and filtering is done based on specified exclusion and inclusion criteria [38].

2.6 Research Motivation

Recent studies show that a lot of work has been done on crowdsourcing, however a lot of areas remain to be considered in macro-task crowdsourcing and we will be discussing on the of its part which is challenges that comes during in the process of applying the macro-task crowdsourcing. Existing techniques are inadequate to address all of the needed and important components of macro-task crowdsourcing issues. An SLR must be done to identify the technical requirements, business, and client factors. This SLR helps to develop a hybrid solution to provide the best possible result in the production of high-quality software by utilizing macro-task crowdsourcing.

The technical, business, and client elements of contemporary procedures are all examined in depth in this study. Elements which are not supported but they are required by existing methods are also mentioned.

2.7 Research Questions

The key objective of this research the investigation of most recent literature in order to critically analyze the most recent software demand prioritizing methodologies. My research also aims to identify present roadblocks to macro-task crowdsourcing. The following is a list of the main topics addressed in this study.

RQ1. Identify the challenges of macro-task crowdsourcing in Software engineering?
RQ2. How can these obstacles be overcome in order to get the best possible results?

2.8 Search Process

In order to get relevant research works, the search technique is meticulously conducted. Seven electronic databases are used to collect research papers. Among the databases evaluated were IEEE, Springer Link, Science Direct, ACM, and Google Scholar. The search strings are created which are built on the research questions and contain a broad range of issues. For data collection, keyword search is used which helps to find specific issues. These keywords are used in a variety of ways to identify all studies that are linked. Kitchenham's theories are used to the creation of search strings. Other search strategies, such as Boolean search, are also employed. The keywords for the search of associated research studies are shown below.

    i.   Crowdsourcing
   ii.   Challenges of crowdsourcing
  iii.   Macro-task crowdsourcing
  iv.   Challenges of macro-task crowdsourcing

Simple search keywords are used to search the existing literature. These keywords are based on research that has previously been published in credible journals.

2.8.1 Study Inclusion and Exclusion Criteria

The emphasis is on challenges of macro-task crowdsourcing features. Primary research filtration is supported by scientific proof support for each field. The criteria to conduct research work are listed below.

2.8.2 Inclusion Criteria

To continue this research inclusion criteria is given below.

    i.   Articles published are written in English.

    ii.   The difficulties of crowdsourcing were highlighted in the papers.

   iii.   Papers discussed on the difficulties of crowdsourcing macro-tasks.

   iv.   Papers addressing the scalability and complexity of macrotask crowdsourcing as major challenges.

    v.   Papers published between 2000 and 2020 in the field of enterprise or macrotask crowdsourcing.

2.8.3 Exclusion Criteria

The exclusion criteria are based on the following important parameters.

    i.   Studies of research not written in English.

    ii.   Simple papers published on the Web.

   iii.   Research which is redundant.

   iv.   Published papers after 2000.

    v.   Papers that fail to address the research questions.

2.8.4 Quality Assessment Criteria

This is used to assess the value of main study investigations. There have been a number of research questions which can assess the value of a research investigation. Each study is granted a set number of points based on the research questions [38]. Dyba et al. provided QAC standards in checklist format. Primary goal of the evaluation criteria Identification and evaluation of the most relevant research studies within the SLR.

2.8.5 Data Synthesis

Data from several challenges of macrotask crowdsourcing approaches will be analyzed in this SLR based on empirical support, reported on macrotask crowdsourcing challenges, scalability and complexity difficulties. Preliminary investigation into the approaches and aspects that have been mentioned will aid in respond to all questions of research.

RQ1 will help to find different challenges of macro-task crowdsourcing.

RQ2 focuses on how to overcome these obstacles in order to attain the best possible results.

Table 2. 1: Related Studies for Crowdsourcing

Paper#	Key Factors	Contribution	Limitations	Years
1	This paper presents the current state of crowdsourcing, as well as significant trends and potential for empirical crowdsourcing research in the computing field of study.	This paper employs SMS technique. With 400 primary papers to evaluate, the report reveals major trends in empirical crowdsourcing research, as well as limitations and opportunities for researchers.	Sources info is missing, results are not implemented on any development process.	2016
2	Volunteers who participate as suppliers in crowdsourcing are not bound by contract. In addition, as the development process progresses, the scale of the project changes, resulting in inefficiency and task failure.	The study's goal is to address these crowdsourcing task failures. A simulation model is presented for this that has three components: discrete events, agent-based simulations, and system dynamics simulations.	In such platforms, the task failure ratio is the most important indicator for determining how effective a scheduling method is.	2018
3	To find out how crowd workers felt about utilizing TopCoder for the first time, a competitive crowdsourcing platform for software development.	The goal of this paper is to learn about and characterize the software development experiences of crowd workers in a meaningful environment, such as the SW CS competitive model.	Needs to be a proposed strategy for the challenges.	2017
4	The purpose of this paper is to summarize the key study areas in this new software development paradigm that includes crowdsourcing.	SLR is the name of the procedure. The solution Proposed Model & Framework are the most researched domains in this development paradigm.	Only focusing the software side of crowdsourcing.	2017
5	Customers can use CRE platforms to find accurate and timely requirements for jobs and projects they are proposing. In the literature, there is no comprehensive review of the primary activities conducted on CRE platforms.	They examine the CRE platforms' processes, particularly the workflow that is utilized to manage the process. The review was used to highlight a number of flaws in the current approach, which led to recommendations for improvements.	This study evaluates a small sample using a questionnaire and a workshop. Although the data appear to be intriguing, more evaluation work is required.	2018
6	Consider the use of crowdsourcing to support the engineering of requirements. While the whole area still has to be thoroughly examined, we will focus on the elicitation of requirements.	They examine the crowd-sourcing literature across a range of areas and draw a set of characteristics that characterize its two main buildings: the crowd and the crowdsources. Two focus groups are concerned with shipment and with the quality of elicitation.	The information obtained is unconfirmed. In some project, you might be able to implement the suggestion.	2016
7	According to a prior study, RE practitioners require both implicit and explicit user feedback in order to detect new and updated requirements and decide which software features to add, develop, or drop. However, a formal account of the diverse types and qualities of user input that can be used for RE is still required.	By conducting a mapping study of the literature on crowdsourcing user feedback for RE, this work fills the gap. They uncovered nine bits of metadata that were used in seven distinct ways to define crowdsourcing user feedback. Activities involving the environment.	Techniques are not universally applicable to all expert systems, and the prerequisites are not clearly evident.	2019

8	SW CS is vibrant and invites masses of people to solve problems via an open call to solutions with prizes for the best solutions. Software Crowdsourcing is a solution.	The aim of research is to evaluation activities to SW CS cooperation as well as methods of communication that might help to remove them.	Needs to be implemented in the industry	2016
9	A thorough examination of the usage of crowdsourcing in software development.	They conclude by identifying trends, outstanding challenges, and future research prospects in Crowdsourced Software Engineering.	For this survey investigation, the most significant challenges to validity are probable bias in literature selection and misclassification.	2016
10	The tasks that are performed in a closed setting by a restricted number of people can be distributed to the population using crowdsourcing.	This paper examines all of the advantages and disadvantages of crowdsourcing in depth.	To understand the benefits of the guideline, the association has the weigh the risks and benefits to take a suitable decision.	2015
11	Crowdsourcing has been successfully used in a variety of situations, ranging from simple chores on Amazon Mechanical Turk to tackling significant industrial problems, such as Incentive. Businesses are increasingly turning to crowdsourcing to fulfil specialized software development projects. However, little research has been done in this area.	An in-depth industry case study of crowdsourcing software development at a large organization is presented in this article. Their case study demonstrates some of the difficulties that can arise while crowdsourcing software development.	The software engineering research community has shown little interest in this area.	2014
12	The ethics and fairness of crowdsourcing approaches have aroused a lot of debate, but these questions have received little scholarly study. Crowdsourcing has been accused by some of exploiting workers and undermining labor rules.	Based on our empirical analysis, they identify ethical concerns and investigate those for which ethical standards have emerged, as well as those that remain unresolved and problematic in crowdsourcing methods.	Based on mostly literature.	2018
13	Crowdsourcing means distributing a task to a large group of people via an open call format, and it has been popular among software professionals recently.	The majority of studies show that crowdsourcing is used for coding and testing activities. Crowdsourcing follows a distinct methodology that prioritizes project planning, task specification, and deployment.	Research study was only covering software side, should also focused more on economic models as well.	2019
14	Crowdsourcing is becoming more popular as a method of enlisting internet participants in organizational tasks.	The paper explores the ethical implications of crowdsourcing in terms of information exchange, economics, and relational elements. To guide the ethical use of crowdsourcing, a guiding framework based on ethics literature is provided.	Collaboration in the workplace is not progressing, and work and business are becoming increasingly virtualized.	2017
15	Traditional Software Inspection is a well-known method for quickly identifying problems in software artefacts and models. Inadequate method and tool support, on the other hand, stymies effective defect detection in large software models.	They use a Crowdsourcing-Based Inspection (CSI) strategy with tool support to focus on inspection teams and fault detection quality. In a feasibility study, 63 inspectors utilizing the CSI method and 12	This concept looks at crowdsourcing, but further research is needed to figure out how CSI teams should be arranged to get the most out of it.	2017

		inspectors using a traditional best-practice inspection methodology looked at the CSI approach.		
16	Labeling enormous datasets has become faster, cheaper, and easier because to crowdsourcing services like Amazon Mechanical Turk.	They provide a labelling process model that considers label uncertainty as well as a multi-dimensional assessment of annotators' abilities. Based on the model, we construct an online algorithm that calculates the most likely value of the labels and annotator abilities. It looks for and prioritizes specialists while looking for labels, while actively rejecting untrustworthy annotators.	The price of an annotation can be dynamically modified to reward high-quality annotations while also influencing the annotators' internal thresholds.	2010
17	Businesses are increasingly turning to crowdsourcing as a means of gaining access to a scalable workforce via the internet. Cloud computing, on the other hand, has emerged as a new paradigm for providing computational services that seamlessly connect the physical and digital worlds via a common infrastructure.	The criteria for creating a general-purpose crowdsourcing service in the cloud are determined in this study using a hypothetical crowdsourcing scenario in the software development sector. It creates a taxonomy for categorizing crowdsourcing platforms and evaluates a number of current systems against the set of recognized criteria.	Research is only based on secondary study.	2009
18	Crowdsourcing is a young field of study in software engineering. The procedure for our crowdsourcing case study at a multinational firm is included in this report.	This protocol contains further information about the study's history, design, and execution.	The research design can also be used to duplicate the case study, making it easier to compare different case studies.	2014
19	In recent years, academic and managerial writings have tackled crowdsourcing. Despite some negative voices, the literature on crowdsourcing is favorable.	In this study, they want to look into the potential drawbacks and concerns that surround crowdsourcing. The overarching purpose of this study is to investigate why crowdsourcing initiatives may not always live up to the elevated expectations placed on them.	While some of the hurdles are unique to a given scenario or industry, there are a few general reasons why crowdsourcing has yet to become the de facto method of operation, particularly in the context of innovation generation.	2013
20	Despite the importance of pricing in crowdsourcing campaigns and the market's complexity, most platforms do not offer requesters with the tools they need to price and assign tasks effectively.	They present a framework for developing crowdsourcing market mechanisms with verifiable guarantees in this study.	This framework needs to be implemented in the industry.	2013
21	The use of IT-enabled crowdsourcing with employees in enterprises has increased dramatically in recent years. Internal crowdsourcing is defined as "internal crowdsourcing," as opposed to "external crowdsourcing" with end users or "hierarchical crowdsourcing" with employees.	The goal of this internal crowdsourced review study is to establish a conceptual framework, synthesize the research, and provide a structured framework.	Not discussed the results after implementation	2016

22	The issue of crowdsourcing has gained in relevance within the broader area of management since 2006, as more academic and practitioner research on the subject has been published. However, no comprehensive assessment of the topic has yet been published in management journals, and the field's description is ambiguous, resulting in its unstructured evolution.	As a result, the authors perform a comprehensive review of the existing body of knowledge on crowdsourcing, outlining its merits and flaws before offering future study areas. The research is based on 121 peer-reviewed studies that were published between 2006 and 2015.	Future study directions are suggested in the form of research questions that are useful for academics and managers alike.	2017
23	Many companies are now promoting crowdsourcing as a new business model for outsourcing jobs formerly managed by a small group of people to an undefined large workforce.	This article aims to provide a better knowledge of crowdsourcing systems and the basic design considerations that go into their construction.	The author developed and showed the components and functionality of a crowdsourcing system.	2013
24	As a potential model for boosting innovation performance, open innovation has gotten a lot of attention. This paper looks at crowdsourcing, an understudied form of open innovation that is frequently aided by the internet.	They focus on a type of crowdsourcing in which monetary rewards are offered and a crowd is tasked with solving problems that solution seekers believe to be empirically verified, but where the source of solutions is unknown and solving the problem in-house is regarded too hazardous.	We look at how open innovation has evolved over time, describe crowdsourcing as an open innovation paradigm, and differentiate crowdsourcing from other types of 'open' invention.	2012
25	To build the most user-oriented and cost-effective solutions, the software development industry uses a variety of models and methodologies. One of the most important variables that determines the entire development process is the choice of an acceptable software-sourcing model.	Every software-sourcing model has advantages and disadvantages. While certain software-sourcing models are effective in particular types of projects, others have limitations that prevent them from being used in others. It is critical for a company to research the benefits and drawbacks of a particular sourcing model before deciding to use it for a project.	In order to determine which model is best suited to which context, this study compares and contrasts crowdsourcing, open-sourcing, outsourcing, and insourcing.	2016
26	Organizations are paying close attention to crowdsourcing because of its competitive benefits over typical work structures in terms of utilizing talents and labor, as well as harvesting expertise and creativity.	This study fills the gap by undertaking a comprehensive evaluation of the literature on crowdsourcing decisions. According to our research, this decision is influenced by nine factors and sixteen subfactors.	We make numerous recommendations for managers considering crowdsourcing based on this paradigm.	2016
27	As large-scale software systems become more intricate, unpredictable, and uncertain, traditional software engineering faces considerable challenges. In the software development field, crowdsourcing initiatives such as Apple App Store and TopCoder have lately proved a feasible and viable answer to the problems.	In this work, they lay a conceptual underpinning for the emerging crowdsourced development process. They outline the basic principles, software architecture, development methodology, and maturity model for crowd workforce motivation, coordination, and governance.	Study is focused on software side mostly.	2015
28	The tutorial delves into a hotly debated topic: crowdsourcing.	They concentrate on crowdsourcing issues such as dealing with structured and unstructured data in web-related content. Many academics and practitioners are now aware of the enormous potential of publicly available crowdsourcing platforms.	The program does not incorporate real-world examples and case studies from years of experience deploying and	2011

			managing crowdsourcing applications in commercial settings.	
29	Crowdsourcing is an online, distributed problem-solving and production model that was recently developed. The model can be seen in Threadless, iStock Photo, Inno Centive, the Goldcorp Challenge, and user-generated advertising challenges.	This article defines crowdsourcing, including its theoretical foundations and examples, as well as the differences between it and open-source output.	The model's potential are also discussed in this article, including how it may be utilized to tap into a crowd of innovators and how it can be implemented outside of the for-profit sector.	2008
30	To distinguish between macro and micro task crowdsourcing. The goal of this study was to look into the costs and benefits of breaking down macrotasks into microtasks for three different task categories: arithmetic, sorting, and transcription.	They discovered that breaking these jobs down into microtasks results in longer overall task completion times, but higher-quality products and a more resilient experience to interruptions.	Study can be further improved	2015
31	Using various facets to define the macro-task crowdsourcing	In this study, they look at macrotask crowdsourcing from a variety of angles, including the nature of the problem it can solve, the skills needed by Crowdworkers, and the work management systems needed.	Not identifying all the future prospects	2019
32	The goal of this chapter is to deepen our understanding of crowd coordination so that we can manage difficult macro-tasks.	This paper identifies research gaps and proposes a research agenda for bettering our understanding of crowd coordination, which is essential to perform complex macro-tasks.	The approach did not present significant drawbacks	2019
33	To use crowds to complete more difficult macro5 activities, you will need a greater understanding of crowdsourcing control.	To address the issues that come with crowdsourcing macro-task controllers. The research focuses on determining how to employ the controls needed to perform macro-tasking in crowds, as well as the implications for crowdsourcing system designers.	Study can be further improved	2019
34	To learn how to deal with cooperative issues in crowdsourcing in a certain location.	They give three case studies of situated crowdsourcing that utilized various located technologies, as well as the reasons for their failures in boosting worker cooperation.	Not discussed the results after implementation	2019
35	While breaking down difficult problems into microtasks is useful in many situations, other problems are not decomposable and necessitate prominent levels of coordination among crowd workers.	They want to learn more about the macrotask crowdsourcing challenge and how to use crowd-AI to solve difficult tasks that are distributed across expert populations and machines.	Not implemented practically.	2019

Table 2. 2: Related Studies for SPM

No#	Topic	Researchers	Key Factors	Benefits	Limitations	Years
1	"A study of agile project management methods used for IT implementation projects in small and medium-sized enterprises"[55].	"Daniel G. O'Sheedy"	Project management methodologies based on industry practices and international standards have been developed to increase the success rate of information technology ventures. These have been shown to be advantageous in large corporations. However, there is frequently a lack of a well-established project management process or qualified project implementers when projects are conducted in a small or medium-sized organization .	The current level of formalized project management is examined, as well as how these approaches could be tailored for a small or medium-sized organization , particularly in the context of information technology installation projects.	Agile project management, which evolved from agile development, holds a lot of promise for filling this gap, and this research was conducted with that goal in mind.	2012
2	"Incorporating PMBOK2004 guidelines into the software project management supported by software agents' model [56]."	"Rita C. Nienaber* and Elmé Smith"	Globalization, advances in computer technology, and the deployment of software projects in distributed, collaborative, and virtual contexts have all changed the software project management environment. Traditional project management solutions do not address these extra challenges.	The authors introduced the SPMSA (software project management assisted by software agents) paradigm, which aims to improve software project management by considering the unique character and dynamic environment of software projects.	Needs to be implemented in the industry.	
3	"Investigation of SPM Approaches for Academic IT – Projects [57]."	"Varsha Karandikar, Ankit Mehra, and Shaligram Prajapat"	Every year, millions of software projects are started, developed, and deployed in the IT sector. Almost a billion dollars has been invested in the development of profitable and useful software. However, many of these efforts fail to meet the needs of users.	We look into the many approaches to project monitoring and management for producing usable software, as well as the quality and success of academic projects in this study.	The study provides a thorough overview of current approaches in use and paves the way for the analysis of academic CS initiatives in Indore areas in the near future.	2017
4	"An Exploratory Study of Gender in Project Management: Interrelationships with Role, Location, Technology, and Project Cos [58]."	"Linda S. Henderson, Richard W. Stackman"	The goal of this research is to see if project manager gender differences are linked to gender differences in their teams. Gender disparities are explored in relation to project managers' and team members' proximity, project team technology use, and project team cost and size.	The likelihood of same-gender project manager and team member dyads, as well as gender variances in project contextual components, are among the notable findings based on log-linear analysis of data from 563 project team members.	The article concludes with implications for organizational and project management researchers and decision makers.	

| 5 | "Towards a conceptual reference model for project management information systems [59]." | "Frederik Ahlemann" | Over the previous decade, project management information systems have evolved significantly. They are no longer solely concerned with scheduling and resource management. Instead, they have evolved into full systems that support projects, project programmers, and project portfolios over their entire life cycle. | Numerous processes must be evaluated, various stakeholder interests must be considered, and appropriate software systems must be chosen. This article's reference information model (RefModPM) addresses this issue and tries to speed up the setup of project information systems. | Model needs to be implemented in industry. | 2009 |
| 6 | "Preliminary Results of a Study of Agile Project Management Techniques for an SME Environment [60]. " | "Daniel G. O'Sheedy, Jun Xu, Shankar Sankaran" | Project management strategies for IT projects have been effectively deployed in large enterprises. Small software teams, on the other hand, have found traditional approaches unmanageable for their needs. | This article describes the preliminary findings of a study that looked at how agile and traditional project management methodologies could be applied in a SME (Small and Medium-Sized Enterprise) setting. | The findings of this study are a useful tool for project managers who work in a fast-paced or rapidly changing setting. | 2010 |

2.9 Summary

Primarily, we conducted a thorough literature review on microtask crowdsourcing in this chapter to find the challenges of the macrotask crowdsourcing. We find eight major challenges of the macrotask crowdsourcing by reviewing the 35 papers from the literature review which are requirements documentation, collaboration, communication, coordination, technical gap, cultural gap, management gap and cost estimation. We also reviewed the software project management literature how can we improve the challenges of macrotask software projects.

CHAPTER 3

METHODOLOGY

3.1   Overview

Quantitative and qualitative methodologies are commonly used [61]. Methodology is not aimed at offering strategies, contrary to a technique. Rather, It sets the conceptual framework. The term "methodology" refers to a theoretical and comprehensive examination methods used for doing research. It includes a conceptual assessment of collective of methods and techniques pertaining to some subject matter. The basis of methodology is establishing the method, processes, or practices that can be applied for investigating a particular question.

3.2   Research Strategy

It is a crucial part of developing research plan. Researchers use research strategy to plan, implement and monitor the work. The research strategy must be based on research processes that help to guide the studies in more detail. Interviews, and questionnaires are the Research methodology examples which demonstrate the analyst how data are collected and analyzed. A particular practice for achieving a certain objective is a research method, while research strategy is a comprehensive.

Therefore, in research, the limitations will be identified via literature review, afterward evaluate using survey in the form of a questionnaire, and then overcome the challenges using focus group method with mitigation strategy fig 3.1.

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│ Review Planning                                          │
│      ┌──────────────────────────────────────────────┐   │
│      │  1.  Research goal and research questions    │   │
│      │      identification                          │   │
│      │  2.  Identifying the keywords                │   │
│      │  3.  Identifying the sources                 │   │
│      │  4.  Identifying the inclusion/exclusion criteria│ │
│      │  5.  Identifying the data extraction strategy│   │
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│ Review Conduction                                        │
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│      │  6.  Identification of research              │   │
│      │  7.  Selection of studies                    │   │
│      │  8.  Study quality assessment                │   │
│      │  9.  Data extraction and monitoring progress │   │
│      │  10. Data synthesis                          │   │
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│                   Result Reporting                       │
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Fig 3.1: Reporting result

3.2.1 Quantitative Research

The process of collecting and analyzing numerical data is known as quantitative research. It may be used to look for patterns and averages, anticipate events, examine causal linkages, and extrapolate results to larger groups of people. Quantitative research methods can be used in descriptive, correlational, or experimental studies [62].

The goal of descriptive research is to gain a broad picture of your study's variables. Correlational research looks into the links between the variables in your study. In experimental research, you are looking for a cause-and-effect link between two variables. In both correlational and experimental research, statistics can be used to formally evaluate hypotheses or predictions. Because of the sampling strategy used, the findings of these two forms of research can be applied to a larger population. To collect quantitative data, you will frequently need to apply operational definitions, which translate abstract notions (like mood) into observable and quantifiable metrics.
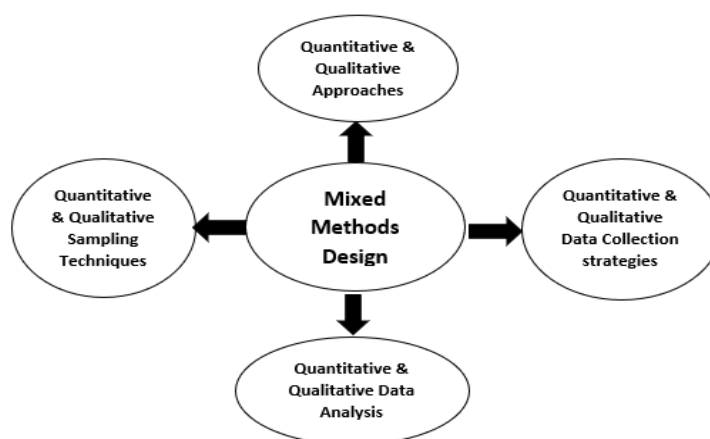
3.2.2 Qualitative Research

Qualitative research is type of method where the researchers are located in the relation with their surroundings. It is a collection of interpretive and material programs that allow people to perceive the cosmos. These activities have far-reaching global implications. They use fieldwork observations, interviews, conversations, photographs, recordings, and self-memo to create a succession of representations of their environment. Qualitative research at that level demands an interpretive, authentic viewpoint. That indicates qualitative researchers look at objects within the natural setting, seeing matters using the lenses of meanings that people give [63].

- Methodologies like case studies are used to create a narrative or event are used in qualitative research. These strategies are widely used by anti-positivist sociologists who favor interpretation above positivism.
- Field notes: create detailed field notes on anything you have seen, heard, or come across.
- Interviews are one-on-one conversations in which you ask the person you are interviewing questions.
- Focus groups: a group of people is asked questions and a dialogue is Focus groups are conversations in which a group of people is asked questions and a dialogue is created.
- Open-ended questions on questionnaires: distribute questionnaires containing open-ended questions.
- Secondary research comprises collecting data that is already available, such as texts, photos, audio or video recordings, and so on.
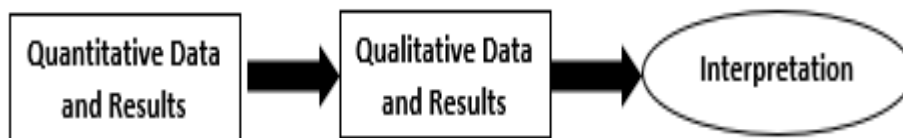
3.2.3 **Mixed Method Research**

Produces the most extensive, comprehensive, and successful study results [64]. Qualitative and quantitative intellectual and practical synthesis is the goal of mixed methods research. This emphasized the significance of conventional quantitative and qualitative study, but also offers a strong, overlooked third paradigm.

Figure 3. 2: Operational Framework Mixed Method Research [65]

According to this technical briefing, mixed methods is being constructed using both qualitative and quantitative approaches fig 3.2. We will do a mixed methodological survey with a quantitative research questionnaire, and then conduct a focus group to discuss the findings fig 3.3.

Figure 3. 3: Process Diagram of Mixed Method Research

3.3   Research Context and Justification

To begin, we will conduct a systematic literature review to identify the challenges of macrotask crowdsourcing, and then, using a questionnaire distributed to industry and professional respondents, A selection of all the challenges will be compiled, and mitigation plans to tackle these challenges. We will then perform focal group with topic experts to develop a mitigation strategy to address the problems of macro-task crowdsourcing.

3.4   Methods and Respondents Profile

To get the justified responses a survey is conducted among the respondents who are expert in crowd sourcing, macro tasking and software engineering.

3.4.1 Survey

A survey tool is usually a critical questionnaire which needs thoughtful consideration. This section examines how survey questionnaires is created. Internal questions include unstructured inquiries which become questionnaires. Intuitive investigations are the main aim or objective of the questionnaire [66].

3.4.1.1   Research Objective

A mitigation plan to meet all the challenges of macro-tasking is the central focus of this study. As a result, the survey is undertaken in the form of a questionnaire in order to answer the following research questions:

RO1: To identify the challenges of the of macrotask crowdsourcing.

RO2: To propose a mitigation plan to overcome those challenges in the macrotask crowdsourcing.

3.4.1.2   Top-down approach/bottom-up approach

The survey's purpose, as well as a statement of desired results or outcome, should be included in the formulations, questions breaking down the problems or interests, such as a sequence of "What, how, and why" questions. The research questions are more fine-grained definitions of the research goals. A poll by exemplifies this top-down logic by van Hersch et al [67], the purpose was to "understand the reasoning process that industrial software engineering practitioners follow when architecting," with the goal being to "understand the reasoning process that software architects follow while architecting." The goal is then divided into research issues by Van Hersch et al. by mapping it to existing literature.

3.4.1.3   Sample Size

According to SLR the sample size is calculated, This involves the collection of a N unit sample in a randomly chosen unit I from a previously ordered N unit sample frame. By continuously adding the interval k, the the next units are selected, (For N and n, the outcome of the whole division). In the population consisting of 200 individuals also the sample size is 50 individuals k=4. When i=3, the sample includes the 10 leading units. Sample size scale from 200 to 250 to receive all of our questions answers.

3.4.1.4   Respondent's profile for survey

Kasunic [68] lays out a set of basic criteria for extracting the most important demographic information from Software Engineering surveys. We will select the respondents on the basis of given conditions.

i.   Size

ii.   Duties, job description

iii.   Educational attainment

iv.   Relevant work experience (D)

v.   Expertise in the field

3.4.1.5   Survey Medium

Our survey will be conducted using the following medium:

i.   LinkedIn

ii.   The Internet and social media

3.4.1.6   Survey Instrument

In lot of instances, a survey tool is an important questionnaire which needs careful consideration. In this section we will discuss that which instruments will be used to conduct survey also how the questionnaires will be created by using main basic research questions. Internal questions are exploratory enquiries that are then divided in different sub questions as survey questions. The main purpose of the survey is to conduct internal assessment.

3.4.1.7   Survey Questions

i.   The working environment follows software development life cycle.

ii.   Crowdsourcing is a technique for obtaining products or services, including ideas, by individuals or organizations.

iii.   Requirement documentation is not documented properly in macrotask crowdsourcing projects.

iv. Communication gap effects the effectiveness in macrotask crowdsourcing projects.

v. Coordination and collaboration effects the macrotask crowdsourcing projects.

vi. Diverse cultural effects the macrotask crowdsourcing projects.

vii. Time period is defined for all the tasks in macrotask crowdsourcing projects.

viii. Software tools can be used to manage time with the tasks in macrotask crowdsourcing projects.

ix. Coordination and collaboration effects the macrotask crowdsourcing projects.

x. Cost estimation changes in the macrotask crowdsourcing projects.

xi. Crowdsourcing also involves voting, micro-tasks, macro-tasks, and financial contributions from a vast, open, and frequently changing group of people.

xii. Macrotask crowdsourcing is a methodology for managing complex tasks with varying degrees of organization and decomposability that may or may not involve people.

xiii. The primary goal of a macrotask crowdsourcing is to set out systematic way of solving the complex projects often rapidly evolving group of participants.

xiv. Have you used any tools in macrotask crowdsourcing projects?

3.4.1.8 Response format

The answers will be collected in a range of forms, such as:

i. Documented questionnaire
ii. surveymonkey.com

3.4.1.9 Survey Justification

A SLR is conducted in the start to identify the challenges of macrotask crowdsourcing, and after this a list the factors will be compiled, and mitigation plans for tackling these challenges, by questionnaire. The questionnaire will be shared with the experts in the industry

to take right responses. Finally, by checking all findings from literature study with professionals and industry experts, the survey aids in the validation of the findings from the literature research.

3.5 Focused Group

As a result, by checking the findings from the literature study with professionals and industry experts, the survey aids in the validation of the findings from the literature research. This group usually consists of people who represent survey researchers and participants. It assesses instruments and facilitates in the detection of ambiguities, as well as questions that are either missing or unneeded. In focus groups, questions are asked in an interactive group style [69]. A group of experts is grouped in focal groups by moderator, these experts should be from 7 to 12 in number. All the experts discuss the questions and give their reviews according to their experiences in a detailed form with examples. The experts discuss on all challenges with each other and give responses openly because of which it helps to extract quality responses.

3.5.1 Respondent's Profile for Focused Group

The following will be used to create responder profiles for the survey:

  i.   Educating experience
 ii.   Professional experience
iii.   Expert in the field

3.5.2 Sample Size Focus group

Our focus group's sample size will be 8–10 qualified responders in order to get answers to all of our questions.

3.5.3 Qualitative Study

Qualitative data can be collected via text, photos, videos, and audio. Interview transcripts, survey results, fieldnotes, or natural sound recordings are just a few examples of what you might be working with. In qualitative research, participants' voices and ideas are typically maintained. Qualitative research is a desirable choice to achieve a range of objectives, such as:

- Flexibility: When innovative concepts or models arise, the data collection and analysis methods can be modified.
- Natural environments: The information is obtained in natural or naturalistic environment.
- Useful insight: The development, testing, and enhancement of systems and products can benefit from detailed accounts of people's experiences, feelings, and perceptions.
- Innovative concepts: Researchers can use open-ended remarks to identify new difficulties or opportunities that they might not have thought of otherwise.

Researchers must address both:

- Due to unpredictable factors that influence data in the actual world, qualitative research is frequently flawed.
- Subjectivity: As the research scientist participates in the evaluation and interpretation of data, it is unable to replicate qualitative data. The researcher decides on practices and theories when it comes to data analysis and interpretation. Qualitative research has various drawbacks: it is tough to discern what is essential and what is not, which leads to multiple interpretations of the same data.
- Limited generalizability: To obtain thorough data regarding specific situations, small samples are typically used. Despite sophisticated research methods, it is difficult to draw generalizable findings since the data may be biased and unrepresentative of the greater population.
- Time-consuming: Data analysis is typically confirmed or completed manually, despite the fact that software can be used to organize and capture enormous amounts of text.

3.5.4   Justification of focus group

First of all, we will recognize the challenges of macrotask crowdsourcing through systematic literature review and then we will list down those challenges and the mitigation plan to overcome those challenges through questionnaire by doing the survey from the industry and professionals.

3.6   Verification and Validation of Framework

In this section, the challenges of macro task crowdsourcing that we will identify from literature review. We will verify them from conducting the survey from the processionals and from industry. Then we will validate those challenges and the mitigation plan through triangulation by validating them through conducting a focus group.

3.7   Quantitative Validation

To quantitatively measure the challenges of macrotask crowdsourcing is called quantitative validations. In this section, we will validate the focus group findings through triangulation. We will contact project managers, managers, directors, product owners and business analyst to discuss all of these challenges of macrotask crowdsourcing. By conducting the focus group, we will validate our challenges from the people who've at least 5 years of experience in macrotask crowdsourcing.

3.8   Qualitative Validation

To qualitatively measure the challenges of macrotask crowdsourcing is called qualitative validations. In this section, we will validate the literature review and survey findings through verification. We will conduct this survey from the population of small to enterprise

level which includes all stakeholders who have worked in macrotask crowdsourcing environment. By conducting the survey, we will validate our challenges from the systematic literature review by finding the chrome alpha value.

3.9   Objectives and Activities

The purpose of this study is to discover crowdsourcing difficulties and then provide a mitigation strategy to increase the success of macrotask crowdsourced projects in software engineering. To conduct those tasks, we do a literature analysis to identify the problems of macrotask crowdsourcing, and then conduct a survey to confirm those challenges. Then we conduct a focus group to confirm the mitigation plan's validity in order to improve the success of macrotask crowdsourcing.

3.10   Summary

We have gone over the research methodology in great detail in this part. Here, we have described research strategies, such as conducting the survey using a blended approach that combines qualitative and quantitative methods. This section describes the research objectives, top-down and bottom-up methodologies, sample size, and characteristics of survey respondents. In this chapter, equipment (survey) survey questions, answer format survey rationale, target group, sample size, target group, focus group focus group questions of sample size to conduct the survey through a qualitative survey.

CHAPTER 4

DATA COLLECTION

4.1   Overview

In this chapter, we will discuss the data collection which we have collected from the survey and focus group. After adding finding the problem and its solution from a thorough literature, it is the phase to validate and justify the findings of these studies. We have used mixed method research to give more precise results. For this purpose, we have conducted a survey on all the major challenges of the macrotask crowdsourcing from the systematic literature review from the industry through google form. It was only online-based survey because of COVID precautions. To conduct the responses from a generous size of population a survey is a god method. A survey of people with experience in the fields of software engineering and crowdsourcing is being undertaken.

Then we will evaluate the survey data through excel sheet by finding the Cronbach alpha value and then we will see how many values are accepted and rejected in the survey. Then we will validate these challenges from the focus group as well. We will conduct the focus group and will see the acceptance and rejection of the values. The focus group is the best way to take more justified responses from respondents. In focus group meeting all the experts of software engineering and crowdsourcing give the responses according to their experience and with detail justifications. This makes focus group more accurate qualitative method of data collection.

4.2   Results from Survey

Table 4. 1*: Final Result of Survey*

No	Factors	Weightage Values	Avg. Weightage Responses	Results
1	The working environment is organized according to the software development life cycle.	232	1.022	Accepted
2	Crowdsourcing is a method of obtaining products or services, including ideas, by individuals or organizations.	219	0.964	Accepted
3	Requirement documentation is not documented properly in macrotask crowdsourcing projects.	220	0.969	Accepted
4	Communication gap effects the effectiveness in macrotask crowdsourcing projects.	219	0.964	Accepted
5	Coordination and collaboration effects the macrotask crowdsourcing projects.	240	1.057	Accepted
6	Diverse cultural effects the macrotask crowdsourcing projects.	238	1.048	Accepted
7	Time period is defined for all the tasks in macrotask crowdsourcing projects.	248	1.092	Accepted
8	Software tools can be used to manage time with the tasks in macrotask crowdsourcing projects.	235	1.035	Accepted
9	Coordination and collaboration effects the macrotask crowdsourcing projects.	240	1.057	Accepted
10	Cost estimation changes in the macrotask crowdsourcing projects.	212	0.933	Rejected
11	Crowdsourcing also involves voting, micro-tasks, macro-tasks, and financial	208	0.916	Rejected

	contributions from a vast, open, and frequently changing group of people.		
12	Macrotask crowdsourcing is a methodology for managing complex tasks with varying degrees of organization and decomposability that may or may not involve people.	209 0.920	Rejected
13	The main purpose of a macrotask crowdsourcing is to serve as a systematic way of solving the complex projects often rapidly evolving group of participants.	215 0.947	Rejected
14	Have you used any tools in macrotask crowdsourcing projects?	181 0.797	Rejected

So, out of a total of 14 options, 9 are chosen and 5 are rejected. To begin, we calculate the average value of all of our responses by multiplying the total number of questions by the sum of all of the average weightage responses.
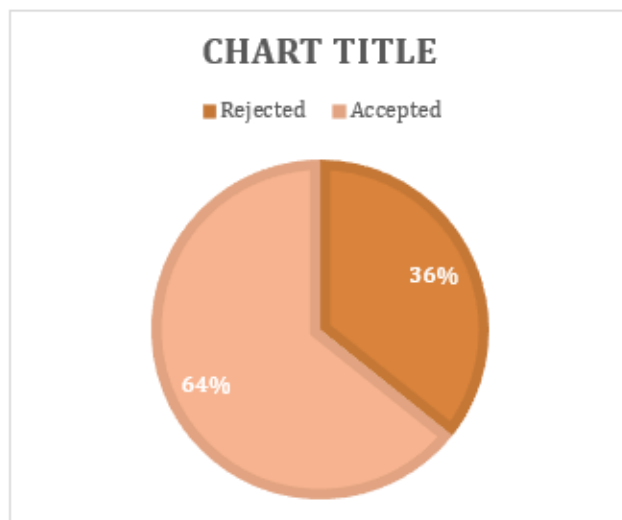
Average Response Value = 12.7/14

$$= 0.95$$

So, the average response value is 0.95 so we considered all the values above 0.95 as accepted and all the values below 0.95 as rejected in above table.

4.3   Results Explanation

As a result of our study, we discovered that 64% of our total values are accepted, whereas 36% of our total values are rejected fig 4.1.

Figure 4.1: Result Chart

4.4 Cronbach Alpha

Scale reliability or the close relation between a number of items, is measured by Cronbach's alpha. It is used to determine how trustworthy a scale is fig 4.2. As the average inter-item correlation rises, Cronbach's alpha climbs as well (assuming the number of items remains constant) [70].

Cronbach's alpha	Internal consistency
$\alpha \geq 0.9$	Excellent
$0.9 > \alpha \geq 0.8$	Good
$0.8 > \alpha \geq 0.7$	Acceptable
$0.7 > \alpha \geq 0.6$	Questionable
$0.6 > \alpha \geq 0.5$	Poor
$0.5 > \alpha$	Unacceptable

Figure 4. 2: Cronbach's alpha value

The most commonly used internal consistency metric is Cronbach's alpha ("reliability"). It is most commonly used when a survey/questionnaire has a lot of Likert items, and you want to see if the scale is dependable.

- Total Number of Questions: 14
- Variance of Total Score: 172
- Sum of items variance: 21.7
- Cronbach's alpha: 0.9401

4.5   Results from Focus Group

Table 4. 2: Focus Group's Final Result

No.	Factors	Average weighted	Results
1.	Do you think the software working environment follows software development life cycle?	1.714	Accepted
2.	Crowdsourcing is a method of obtaining products or services, including ideas, by individuals or organizations.	2.000	Accepted
3.	Crowdsourcing also involves voting, micro-tasks, macro-tasks, and financial contributions from a vast, open, and frequently changing group of people.	0.571	Rejected
4.	Macrotask crowdsourcing is a methodology for managing complex tasks with varying degrees of organization and decomposability that may or may not involve people.	0.857	Rejected
5.	The main purpose of a macrotask crowdsourcing is to serve as a systematic way of solving the complex projects often rapidly evolving group of participants.	0.286	Rejected
6.	Requirement documentation is not documented properly in macrotask crowdsourcing projects.	1.714	Accepted
7.	Communication gap effects the effectiveness in macrotask crowdsourcing projects.	2.000	Accepted

8.	Coordination and collaboration effects the macrotask crowdsourcing projects.	2.000	Accepted
9.	Have you used any tools in macrotask crowdsourcing projects?	0.571	Rejected
10.	Diverse cultural effects the macrotask crowdsourcing projects.	1.143	Accepted
11.	Software tools can be used to manage time with the tasks in macrotask crowdsourcing projects.	2.000	Accepted
12.	Time period is defined for all the tasks in macrotask crowdsourcing projects.	1.429	Rejected
13.	Cost estimation changes in the macrotask crowdsourcing projects.	1.429	Accepted
14.	SPM techniques can be used in macrotask crowdsourcing projects.	1.714	Accepted

As a result, 9 possibilities are picked and 5 are discarded out of a total of 14. We calculate the sum total all values first, afterward the weighting value of all responses, and finally, the values more than or equal to 0.95 are considered expected, while all values below 0.95 are rejected.
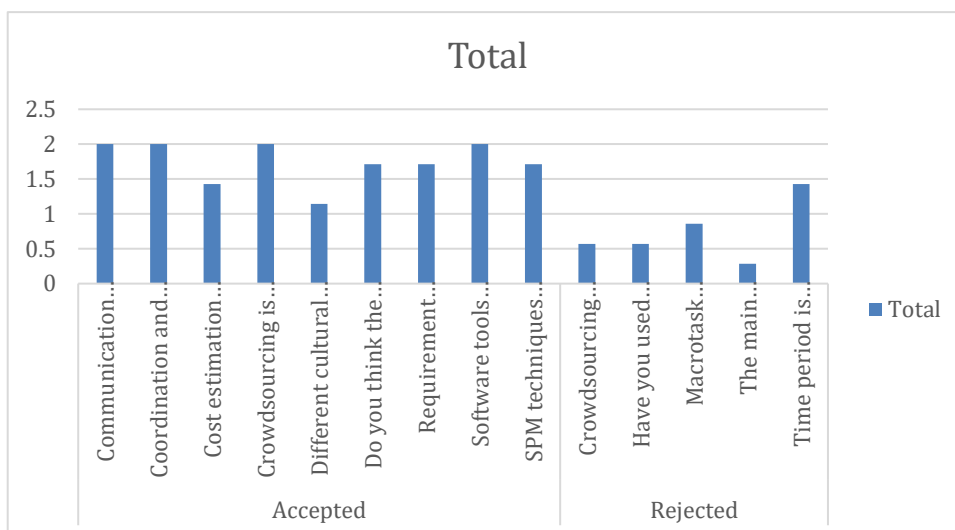
Figure 4. 3: Focus group final results

4.6   Summary

Research question 1 is validated in this chapter in which challenges of microtask crowdsourcing are validated from experts. A survey was conducted to identify these challenges which we have already found through systematic literature review. These challenges are requirement documentation, communication, coordination, cost estimation and time. The result of survey is added in this chapter in which 5 factors out of 14 are rejected. Then to validate the result of survey focus group was conducted and the results were added in this chapter. In final result of focus group 5 values out of 14 are rejected. To analyze and give justified result from both methods chapter 5 discusses the results of research question two and analysis of results.

CHAPTER 5

RESULTS AND ANALYSIS

5.1 Overview

The outcomes are analyzed in this chapter from survey and focus group is done by using triangulation process. Also, to support question two an expert review is done. Through expert review the research question two in giving software project management guidelines to mitigate the challenges in microtask crowdsourcing.

5.2 Results and Analysis

To strengthen the credibility and validity of study findings, the triangulation method is applied.

1. Validity is the amount to which research accurately represents or analyses the notion or ideas under inquiry; credibility is the extent to which a study accurately reflects or examines the concept or concepts under investigation.

2. By combining hypotheses, techniques, or observers, triangulation process helps to identify the final result by using the results of 2 or more methods. Triangulation is an attempt to investigate and describe complicated human behavior using a range of approaches in order to provide readers with a more balanced explanation.

3.   It is a strategy for validating data that can be used in both quantitative and qualitative research.

Triangulation compare the results of two or more methods and then five the final results by using the dominant values. The survey data were analyzed and validated using a focus group, which is a qualitative method. A triangulation method is used on both survey and focus group results to further explore and validate the findings. In this research the results of focus group and survey will be compared for more justified and validated results.
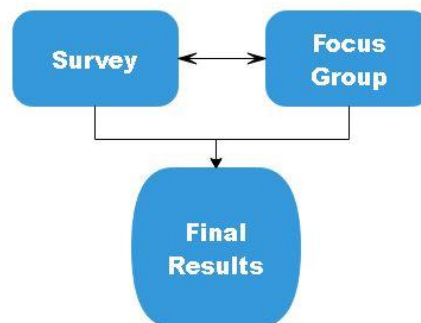
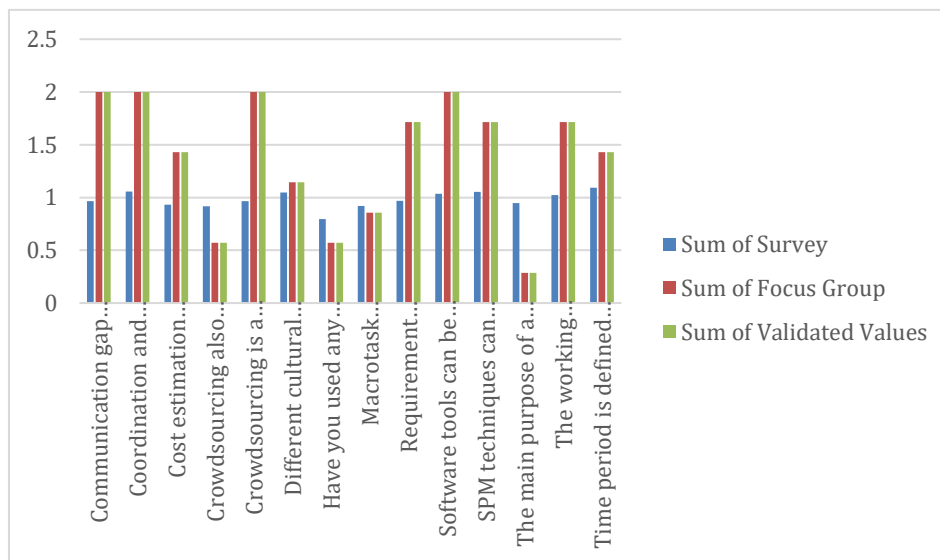**Figure 5. 1**: Triangulation Process

As previously said, here the final outcome that supports the study report will be provided. So indicated by good responses, experts agree that macrotask crowdsourcing has drawbacks. There is a plan in place to alleviate these limits, resulting in more consistent and dependable macrotask crowdsourcing. Table given below is comparing the results of the two techniques To find out which results are more accurate.

Table 5.1 : Results and Analysis

No	Questions	Survey	Focus Group	Validated Values	Final Results
1	The working environment is organized according to the software development life cycle.	1.022	1.714	1.714	Accepted
2	Crowdsourcing is a method of obtaining products or services, including ideas, by individuals or organizations.	0.964	2.000	2.000	Accepted
3	Crowdsourcing also involves voting, micro-tasks, macro-tasks, and financial contributions from a vast, open, and frequently changing group of people.	0.916	0.571	0.571	Rejected
4	Macrotask crowdsourcing is a methodology for overseeing complex tasks with varying degrees of organization and decomposability that may or may not involve people.	0.920	0.857	0.857	Rejected
5	The main purpose of a macrotask crowdsourcing is to serve as a systematic way of solving the complex projects often rapidly evolving group of participants.	0.947	0.286	0.286	Rejected
6	Requirement documentation is not documented properly in macrotask crowdsourcing projects.	0.969	1.714	1.714	Accepted
7	Communication gap effects the effectiveness in macrotask crowdsourcing projects.	0.964	2.000	2.000	Accepted
8	Coordination and collaboration effects the macrotask crowdsourcing projects.	1.057	2.000	2.000	Accepted
9	Have you used any tools in macrotask crowdsourcing projects?	0.797	0.571	0.571	Rejected

10	Diverse cultural effects the macrotask crowdsourcing projects.	1.048	1.143	1.143	Accepted
11	Software tools can be used to manage time with the tasks in macrotask crowdsourcing projects.	1.035	2.000	2.000	Accepted
12	Time period is defined for all the tasks in macrotask crowdsourcing projects.	1.092	1.429	1.429	Rejected
13	Cost estimation changes in the macrotask crowdsourcing projects.	0.933	1.429	1.429	Accepted
14	SPM techniques can be used in macrotask crowdsourcing projects.	1.052	1.714	1.714	Accepted

We discovered that out of the total 14 values, 10 are accepted utilizing the triangulation technique, which compared the results from the survey and focus group and 4 values are rejected. Here are the final results of our triangulation process.

Figure 5. 2: Final result after Triangulation Process

The following are four low significance criteria that were rejected by the respondents:

1: Have you used any tools in macrotask crowdsourcing projects?

Reason: Respondents either do not have a lot of experience in macrotask crowdsourcing or unable to understand this question.

2: Crowdsourcing also involves voting, micro-tasks, macro-tasks, and financial contributions from a vast, open, and frequently changing group of people.

Reason: Respondents either do not have a lot of experience or unable to understand this question that crowdsourcing Crowdsourcing also involves voting, micro-tasks, macro-tasks, and financial contributions from a vast, open, and frequently changing group of people.

3: Macrotask crowdsourcing is a methodology for overseeing complex tasks with varying degrees of organization and decomposability that may or may not involve people.

Reason: Respondents either do not know what macrotask crowdsourcing is or do not comprehend what it means. Macrotask crowdsourcing is a paradigm for managing complex work with varying degrees of organization and decomposability that may involve people.

4: The primary aim of a macrotask crowdsourcing is to provide a systematic way of solving the complex projects often rapidly evolving group of participants.

Reason: Respondents either lack experience or are unable to comprehend the basic aim of macrotask crowdsourcing, which is to function as a systematic way of addressing complex projects involving a quickly changing number of participants.

The following are nine high relevance variables that were accepted by the respondents:

1: The working environment is organized according to the software development life cycle.

Reason: Respondents either have a lot of experience or understand this question that the working environment follows software development life cycle.

2: Crowdsourcing is a method of obtaining products or services, including ideas, by individuals or organizations.

Reason: Individuals or corporations use crowdsourcing to receive goods or services from others, including ideas. Respondents either have a lot of experience or understand the question well.

3: Requirement documentation is not documented properly in macrotask crowdsourcing projects.

Reason: Respondents either have a lot of experience or understand this question that requirement documentation is not documented properly in macrotask crowdsourcing projects.

4: Communication gap effects the effectiveness in macrotask crowdsourcing projects.

Reason: Respondents either have a lot of experience with macrotask crowdsourcing projects or understand how communication gaps affect their performance.

5: Coordination and collaboration effects the macrotask crowdsourcing projects.

Reason: Respondents either have a lot of experience or understand this question that coordination and collaboration effects the macrotask crowdsourcing projects.

6: Diverse cultural effects the macrotask crowdsourcing projects.

Reason: Respondents either have a lot of experience or understand this question that diverse cultural effects the macrotask crowdsourcing projects.

7: Time period is defined for all the tasks in macrotask crowdsourcing projects.

Reason: Respondents either have a lot of experience or understand this question that time period is defined for all the tasks in macrotask crowdsourcing projects.

8: Software tools can be used to manage time with the tasks in macrotask crowdsourcing projects.

Reason: Respondents either have a lot of experience or understand this question that software tools can be used to manage time with the tasks in macrotask crowdsourcing projects.

9: Coordination and collaboration effects the macrotask crowdsourcing projects.

Reason: Respondents either have a lot of experience or understand this question that coordination and collaboration effects the macrotask crowdsourcing projects.

5: Cost estimation changes in the macrotask crowdsourcing projects.

Reason: Respondents either have a lot of experience or understand this question that cost estimation changes in the macrotask crowdsourcing projects.
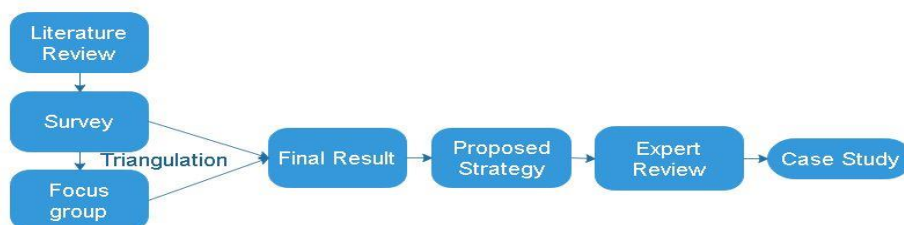
Figure 5. 3: Methodologies to Propose Strategies

5.3 Proposed Strategies

So, to our second question, how can these macrotask crowdsourcing problems be mitigated. SPM (software project management) is a method for planning and coordinating software development projects. Software project management (SPM) is the process of planning, organizing, monitoring, managing, and leading a software project [71]. SPM for Macrotask crowdsourcing, on the other hand, comprises enlisting the help of a vast number of globally

distributed managerial and technological resources to build high-quality software at the lowest cost and time possible. In agile management methods such as scrum, extreme programming, feature driven development, and crystal, SPM benefits include facilitating task coordination and allocation decisions, providing transparency of work progress to all partners, and providing a good picture of how the project is progressing [71]. SPM also makes communication planning and management a breeze, especially when flow mapping is utilized to form teams. SPM provides a means for updating the code as well as some capacity for managing concurrent changes in a systematic manner in the change management technique. In a knowledge management system, It also simplifies the processes of sharing, distributing, producing, recording, and comprehending firm data.

There is a relationship between SPM and risk. To be a part of a software project, risk management is essential. All steps of a software project, including planning, analysis, design, implementation, and maintenance, are fraught with risk. Furthermore, risk is a difficult term to describe and comprehend, as it refers to a variety of objects and individuals [72]. In this study propose a mitigation plan by using SPM techniques. We propose the below the mitigation plan for each challenge of macrotask crowdsourcing.

- SPM tool (Modern Requirements Software) can be used to improve Requirement documentation in macrotask crowdsourcing.
- SPM tools (Cloud-based technology AND SaaS) can be used to improve collaboration in macrotask crowdsourcing.
- SPM tools (Scrum meeting/Slack, Teams) can be used to improve communication gap in Macrotask crowdsourcing.
- SPM Classic technique/written communication may help bridge the geographical/cultural gap in Macrotask crowdsourcing?
- SPM collaborative tools (Jira, Asana, MS) to improve coordination gap in Macrotask crowdsourcing.
- SPM technique Extreme Project Management can be used to improve technical gap in Macrotask crowdsourcing.
- SPM technique Pert, scheduling can be used to improve time management gap in Macrotask crowdsourcing.

5.4 Expert Review

Expert review is a type of heuristic evaluation that is also known as expert analysis, heuristic review, or heuristic evaluation. It is an expert-based research method, as opposed to user-centered methodologies like the usability test. The test product is evaluated by multiple specialists in order to reveal the bulk of its usability flaws. Usability experts evaluate a product or application using established usability criteria and guidelines in an expert evaluation. Major usability difficulties and product enhancement potential are identified by an expert's perspective [73]. The quality of an expert review is determined not only by a systematic and methodical approach, but also by the experts' knowledge and experience, as well as their knowledge of a specific industry and/or experience with similar applications. Rather than relying on rigid checklists, we believe it is critical to review each website on an individual basis, with its own set of objectives and tasks. In the review, we are also happy to consider your analytics data or any other information you have available.

Expert review can help us to validate our second question which is how to mitigate these challenges of macrotask crowdsourcing. In this phase, we are going to propose some mitigation plans for these challenges and then we will do an expert review to validate our proposed mitigation plan to achieve the maximum results of macrotask crowdsourcing projects. First of all, we find out the people with the 6 plus years of experience in macrotask crowdsourcing both as a crowd and sources and then we asked all of these challenges and issues with them and asked about their view about these mitigations' strategies of macrotask crowdsourcing challenges.

Table 5.2: Expert Review

No	Challenges	Mitigation Strategies	R1	R2	R3	R4	R5	Results Summary
1.	Requirement Documentation	Modern Requirements Software	By using modern requirement software tool, we can improve requirement documentation in macrotask crowdsourcing.	Modern Requirements Software should be using in requirement documentation in macrotask crowdsourcing projects to avoid ambiguity.	Modern Requirements Software is extremely helpful in our requirement documentation process in the macrotask crowdsourcing.	Requirement Documentation process can be improved by using some specific tool like modern requirements.	Requirements should be documented and managed using a modern tool in macrotasks crowdsourcing. E.g., Jama, Orcanos etc.	Highly Recommended
2.	Collaboration	Cloud-based technology AND SaaS	Cloud-based technology AND SaaS can be immensely helpful in collaboration not only within the team but all the stakeholder as everything will be accessible and at one place.	Usage of Azure cloud-based technology brings clarity between the developer and the development team in macrotask crowdsourcing.	Collaboration is essential for macrotasks crowdsourcing initiatives to succeed, and cloud-based technology allows for real-time collaboration on large projects.	Cloud-based technology will help to better collaboration among the distributed teams.	Coordination among the distributed stakeholders could be enhanced using high quality cloud-based technology.	Recommended
3.	Communication	Scrum Meetings	Scrum Meetings after some specific time of period in macrotask crowdsourcing projects definitely helps in better	Scrum meeting has always helped me in staying on the top of macrotask crowdsourcing projects as there is an enormous difference between real and	In macrotask crowdsourcing projects the scrum meeting is vital and can save a lot of time and resources which might harm the success of project.	Usage of scrum meetings after a specific time of period will be helpful in better communication among the teams.	For improved communication scrum tools plays a key role. For which sprint planning meeting, daily standup meeting,	Highly Recommended

			communication among all the stakeholders on live projects.	state requirements in live projects.			sprint review meeting, sprint retrospective meeting etc.	
4.	Geographical / cultural gap	Classic technique/written communication	Classic techniques can be used to cover the geographical or cultural gap as we convert all the requirements into tasks and prioritization.	Classic technique is immensely helpful in covering geographical gap by using some specific tools just like n Task.	Geographical gap could be covered by using some classic techniques in the form of written communication where we can elaborate all the task.	Written communication has always helped in covering the cultural gap among the teams.	The waterfall techniques and some other techniques will be best for the improvement of gaps.	Recommended
5.	Coordination	Jira, Asana, MS	Coordination is improved when we use project management tools just like Jira, Asana and Microsoft.	Yes, when we use project management systems like Jira, Asana, and Microsoft, we increase coordination. It is really recommended.	Coordination tools like Jira, Asana should be using in the macrotask crowdsourcing to avoid any challenges.	Jira, Asana or MS tools is 100% recommended in coordination of macrotask crowdsourcing projects.	Software coordination tools like Jira and asana can be proved to be the best solution for project completing on time.	Highly Recommended
6.	Technical gap	Extreme Project Management	EPX helps covering technical gap in macrotask crowdsourcing projects.	In macrotask crowdsourcing projects, EXP should be used as it helps to avoid complexity.	I have been using EXP practices in all of my macrotask crowdsourcing projects. So, this highly recommended.	EXP could be extremely helpful in macrotask crowdsourcing projects.	The performance, reliability and availability are the types of technical gaps which can be improved by using microtask crowdsourcing tools. E.g., EXP	Recommended
7.	Management gap	Pert, scheduling	Pert, scheduling really helps in managing the	Pert, scheduling is very highly recommended in covering the management gap.	This project management technique should be practicing	Highly recommended Pert and some other tools	To manage the project at each level help to complete it	Highly Recommended

			projects and stay on the top of macrotask crowdsourcing projects.		in the macrotask crowdsourcing projects.	for project management	on time and under budget. Pert and GanttPRO are best solutions.	

5.5 Results from Expert Review

As a result, we conducted our expert assessment by addressing these questions to industry experts with substantial experience in macrotask crowdsourcing efforts. Our professional reviewers all provided us positive feedback on the mitigating solutions we advised. As a result, we have categorized our responses into two categories: recommended and highly recommended. Here are the results of each macrotask crowdsourcing projects. For the requirements documentation challenge in macrotask crowdsourcing, we proposed that if we use some software tool to manage and organize the requirement documentation just like Modern Requirements Software which is being used globally for the requirement documentation. So, by asking this mitigation strategies to all the respondents. Everyone recommends using this Modern Requirements Software in place of general classic technique. So, by seeing most of the responses as highly recommended we summaries that this mitigation strategy is highly recommended.

For the collaboration challenge in macrotask crowdsourcing, we proposed that if we use some cloud-based technology and SaaS to organize the collaboration within all the stakeholders then collaboration within the team can be made better. SaaS (software as a services) is a type of azure cloud-based technology where we use software as a service. So, by asking this mitigation strategies to all the respondents. Everyone recommends using this cloud-based technology and SaaS in place of general collaboration techniques. So, by seeing all the responses we summaries that this mitigation strategy is recommended.

For the communication challenge in macrotask crowdsourcing, we proposed that if we use some online scrum meeting to organize the communication within the stakeholders then communication within the team can be improved. Online meeting is a type of scrum meeting where everyone comes and discuss all the aspects of projects. Everyone recommends using this online meeting in place of general communication. So, by seeing all the responses we summaries that this mitigation strategy is highly recommended. For the geographical cultural gap in classical gap, we can use classic technique/written communication as it can be used to cover up the geographical cultural gap, as in the classical communication convert it into task and prioritization. It can be beneficial as it uses some tools just like n task. Written communication works by covering all the task into the teams crystal clearly. Everyone

recommends using this online meeting in place of general communication. So, by seeing all the responses we summaries that this mitigation strategy is recommended.

For the coordination challenge in the macrotask crowdsourcing, we proposed that if we use some collaborative tools like Jira, Microsoft, asana to organize the coordination within all the stakeholders then coordination within the team can be made better. By proper collaboration with each other live in the projects, the results can be improved. Everyone recommends using the tools like Jira, Microsoft in place of general coordination techniques. So, by seeing all the responses we summaries that this mitigation strategy is highly recommended. For the technology gap challenge in the macrotask crowdsourcing, we proposed that if we use extreme project management in the macrotask crowdsourcing projects then we can improve the results. Extreme project management is a technique for managing projects that are both complicated and uncertain. The open, elastic, and indeterministic style of extreme project management distinguishes it from regular project management. Everyone recommends using the Extreme project management in place of other techniques. So, by seeing all the responses we summaries that this mitigation strategy is recommended.

For the management gap in macrotask crowdsourcing, we proposed that we improve the results by using pert and scheduling in macrotask crowdsourcing projects. The Program Evaluation Review Technique (PERT) is a planning technique for project management for determining how long it will take to complete a project in a reasonable amount of time. PERT charts are used to arrange work inside a project, making it easier to schedule and coordinate team members. To manage tasks, everyone suggests using pert and scheduling. As a result of looking at all of the responses, we can conclude that this mitigation method is highly recommended.

5.6 Case Study 1

The iLearn system is a digital learning environment that is used in schools to promote learning in children aged 4 to 18. It will take the place of an existing system (Glow), which was created specifically for the purpose and includes its own e-mail and other applications. Users could not add their own programs to Glow because it was a closed system. It was becoming

less and less popular as the capabilities of openly available systems surpassed those of the closed system. One of the most significant criteria for the iLearn system was that it be open, allowing new features and existing services to be easily added. We attempted to do this by building the system so that everything was a service and that users could replace pre-specified services with their own service versions with necessary rights. This technique also allowed us to cope with the complexities of integrating with current network control systems (local areas had varying regulations on which web sites school pupils could visit based on age and content) and school administration systems. By generating a service line to these systems, unlike underlying systems could be put up.

In this system, there are three categories of services:

- Utility services are system-wide services that provide basic capability that is not dependent on the application and are accessible to other services. Utility services are usually custom-built or adapted for this system.
- Application services that give users access to instructional content like scientific films or historical resources, as well as specific apps like email, conferencing, and photo sharing.
- External application services are services that are either specifically purchased for the system or are freely available through the Internet.
- Services of configuration describe how services are shared across students and adapt the environment to a certain set of application service teachers, and parents.

Throughout this project, I experimented with a variety of software engineering techniques, including viewpoint-oriented requirements, use-cases, and UML modelling. All of them were a failure. User stories were the only technique that worked since they were relatable to those who did not have a technical expertise. The key reasons for the failure of these software engineering methodologies were, primarily, that users were unconcerned about system needs and lacked time to interact with the development team. Second, stakeholders did not comprehend the terminology or methodologies employed; phrases like use-case made no sense to them.

The first problem, disengaged users, is becoming increasingly widespread. Because there is so much low-cost or free software available, consumers can create their own working methods and see no need for a corporate system. In some cases, this is due to a lack of understanding of concerns such as security, while in others, the issue is that the benefits of corporate systems are for the company rather than the end-user. End-users have every right not to want to devote time away from their regular jobs to discuss modern technologies that provide them no real benefits. As a result, developing requirements for systems with a varied user base is becoming more complex.

5.6.1 Solutions

- An open system that could easily manage new features and current services was one of the most critical criteria for the iLearn system. Macrotask Crowdsourcing is also an open-source system for the big systems, and they are created on latest technology so there is enough storage and capability to add new features and technology.
- Users were unconcerned about system needs and lacked the time to communicate with the development team. For better requirement gathering and interaction with development team and stakeholders multiple Tools for communication and collaboration are used in macro tasking crowdsourcing for instance: slack.
- Second, stakeholders did not comprehend the terminology or methodologies employed; phrases like use-case made no sense to them. Online meetings and video meetings feature in macro tasking crowdsourcing helps them to explain and understand all the details.
- Another issue is disengaged users, which is increasingly common. Using communication platforms and project management tools like Jira can help to engage all the stakeholders.
- In some respects, they have security issues. Macrotask Crowdsourcing gives secured system.
- The issue is that the advantages of a corporate system favor the organization rather than the end-user. In macrotask crowdsourcing end users are always in good contact and end-users can give their feedback also.

- As a result, developing requirements for systems with a varied user base is getting more complex. Macrotask Crowdsourcing is a diversity in its features, and they are improving with the time.

5.7 Summary

In this chapter results from survey and focus group are analyzed to validate research question 1. A triangulation process is done in which the results of both methods are compared, and then dominant values are taken as final result. According to triangulation process 5 factors were rejected and 9 factors are the high significance factors. The challenges validated by triangulation process are than discussed to find the best solutions to improve them. Research question two was validated by conducting the expert review in which software project management guidelines are recommended to be the best solution of challenges in microtask crowdsourcing. Also, a case study is done in this chapter which is using the software project management guidelines to solve the challenges in of macrotask crowdsourcing and producing the improved systems. Both research questions of thesis are validating and supporting the thesis. The next chapter is concluding the whole thesis

CHAPTER 6

CONCLUSION AND FUTURE WORK

6.1　Overview

The main objective of this thesis is the investigation of finest ways for overcoming difficulties of macrotask crowdsourcing in software engineering projects. The thesis is built around two research issues that are examined and evaluated in order to provide software project management principles for macrotask crowdsourcing. So, research is divided in two research questions.

Q1: What are the challenges of Macrotask crowdsourcing?

The first question was what the challenges of macrotask crowdsourcing are. So, in order to answer this question, we conducted a comprehensive literature review to discover the challenges of macrotask crowdsourcing. We reviewed the 35 papers related to the macrotask crowdsourcing and from these papers we find out the eight challenges of macrotask crowdsourcing which are requirements documentation, collaboration, communication, coordination, technical gap, cultural gap, management gap and cost estimation. The challenges are then validated through a survey and focus group. We conducted an industry survey to confirm the challenges identified in the systematic literature review. Then to verify the results of survey we did a focus group from the experts.

Q2: How to mitigate these challenges of Macrotask crowdsourcing to achieve maximum results of macrotask crowdsourcing?

The second question we had was how to deal with the difficulties of macrotask crowdsourcing. For each challenge of macrotask crowdsourcing, we offered mitigation solutions based on software project management practices. Then to validate our mitigation strategies, we did an expert review from the industry by the people who have 5 plus years of experience in macrotask crowdsourcing. We validated our proposed mitigation strategy through expert reviews. There was only positive response from the experts in the form of recommended and highly recommended. Then we present a solution of a case study through our proposed mitigation strategy to support our study.

6.2 Summary of Contribution

Here is the contribution of our research study. This research is contributing to society in many ways.

- The researchers can easily find the challenges of macrotask crowdsourcing projects and also its mitigation strategies to improve the results of macrotask crowdsourcing projects.
- Because our study outlines all of the obstacles associated with macrotask crowdsourcing, reviewing them before embarking on a new macrotask crowdsourcing project can be extremely beneficial in the future.
- Our mitigation strategy can be extremely helpful in resolving the challenges of macrotask crowdsourcing and to achieve maximum results of macrotask crowdsourcing software projects.

6.3 Limitations

- In our study we have proposed solutions to 7 challenges of macrotask crowdsourcing except the cost estimation challenge of macrotask crowdsourcing.

- Our study is only focusing the macrotask crowdsourcing software projects.

6.4 Future Work

Since there is one challenge of cost estimation in macrotask crowdsourcing still needs a mitigation strategy so future research can be based on cost estimation challenge of macrotask crowdsourcing. Also, we can broad our study out of software engineering projects by focusing other areas.

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APPENDIX A

SURVEY QUESTIONNAIRE

SURVEY TO VALIDATE THE CHALLENGES OF MACRO-TASK CROWDSOURCING IN SOFTWARE ENGINEERING PROJECTS

Investigations has proved that the dynamic reason of project failure in macrotask crowdsourcing is the deficient of collection with the requirements, gap of communication, proper collaboration within the team. The major agenda of the project must be fulfilled accordingly.

Crowdsourcing involves obtaining work, information, or opinions from a large group of people who submit their data via the Internet, social media, and smartphone apps. People involved in crowdsourcing sometimes work as paid freelancers, while others perform small tasks on a voluntary basis.

Macro task crowdsourcing refers to a model that is designed to handle complex work of different degrees of structure and decomposability that potentially involve the workers.

This research basically educates us regarding the challenges of the macro-task crowdsourcing in software engineering projects and develops the best practices to minimize these challenges during the building macrotask crowdsourcing projects.

Personal Information

Name *

Your answer

Company Name *

Your answer

Have you worked on a macro task crowdsourcing project using crowdsourcing platforms (Upwork, fiver, top coder, etc.)?

◯ Yes

◯ No

Gender *

◯ Female

◯ Male

Designation *

Your answer

Experience *

◯ > 2 year

◯ > 4 year

◯ > 6 year

◯ > 8 year

◯ > 10 year

Back   Next   Clear form

Challenges

This survey basically educates us regarding the challenges of the global software development in software engineering projects and develops the best practices to minimize these challenges during the building global software development projects.

What are the challenges of macro task crowdsourcing? *

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
The crowdsourcing working environment follows the software development life cycle.	○	○	○	○	○
Crowdsourcing is a model in which individuals or organizations obtain goods or services including ideas.	○	○	○	○	○
Crowdsourcing also includes voting, micro-tasks, macro-tasks, and finances, from a large, relatively open, and often rapidly evolving group of participants.	○	○	○	○	○
Macro task crowdsourcing refers to a model that is designed to handle complex work of different degrees of structure and decomposability that potentially involve the workers.	○	○	○	○	○

The main purpose of macro task crowdsourcing is to serve as a systematic way of solving complex projects often rapidly evolving groups of participants.	○	○	○	○	○
Requirement documentation is not documented properly in macro task crowdsourcing projects.	○	○	○	○	○
The communication gap affects the effectiveness of macro task crowdsourcing projects.	○	○	○	○	○
Coordination and collaboration effects the macro task crowdsourcing projects.	○	○	○	○	○
Have you used any tools in macro task crowdsourcing projects?	○	○	○	○	○
Different cultural effects of the macro task crowdsourcing projects.	○	○	○	○	○
Software tools can be used to manage time with the tasks in macro task crowdsourcing projects.	○	○	○	○	○

The time is defined for all the tasks in macro task crowdsourcing projects.	○	○	○	○	○
Cost estimation changes in the macro task crowdsourcing projects.	○	○	○	○	○
SPM techniques can be used in macro task crowdsourcing projects.	○	○	○	○	○

⚠ This question requires one response per row

Back   Submit   Clear form

APPENDIX B

SURVEY LINK

SURVEY TO VALIDATE THE CHALLENGES OF MACRO-TASK
CROWDSOURCING IN SOFTWARE ENGINEERING PROJECTS
Investigations has proved that the dynamic reason of project failure in
forms.gle

Hi!!

I am Muhammad Usman, MS Software Engineering student at the National
University Of Modern Languages Islamabad. I am in the process of making my
thesis, the topic being "The Challenges of Macro-Task Crowdsourcing".

As part of my primary data collection, I am conducting a survey regarding
people's preferences towards macro task crowdsourcing. I would need only a
few minutes of your time to fill out a questionnaire which forms a
comprehensive part of my research. Your responses hold a great significance in
my quest of data collection.

Please find the questionnaire link attached and feel free to add any additional
comments. If you face difficulty answering any question, you could leave it
blank. https://forms.gle/mmVrABXrAS9jy9ky5

Thank you very much in advance for your assistance.

Best!

Muhammad Usman
usmandilawar786@gmail.com

3:01 am