FACTORS AFFECTING CROWD PARTICIPATION TIME IN CROWDSOURCING CONTESTS

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A thesis submitted in fulfillment of the
Requirements for the award of the degree of
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DECLARATION

I declare that this thesis entitled "*Factors Affecting Crowd Participation time in Crowdsourcing Contests*" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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Date : Sep 23rd 2021

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

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ABSTRACT

The crowd is generally considered as a group of people who gather for the same cause but are not generally related or interconnected to each other. While a software crowdsourcing contest can be regarded as one of the newly invented and highly innovative modes of crowdsourcing, it is also considered to be one of the highly accepted setup for an organization to announce and implement an open call of their desired task online. Crowd participation time is one of the main reason that plays an essential role in completion of the task. Researches based on solver participation in crowdsourcing contests proved to be helpful in comprehension and manageability of the motivations of solvers to take part in the online software crowdsourcing platform. So, what could be the strategy to attract more participants to participate in the contest and motivate them to put in more effort and time, is the main focus of this research work. Previous studies have been found to measure the submission rate in order to figure out the rate of solvers participation in software contest. They are lacking in formulation of the feasible suggestions on the average rate of participation effort, payout by a participant in software development tasks such as bug fixing and interface evaluation. This resrach has been conducted through SLR followed by the expert review appraoch. SLR has been conducted to extract factors that affect participation time from existing literature, and subsequently, the identified factors went through an expert review for validation of these identified factors. A list of factors has been identified that will be helpful for industry practitioners and for acadmeicians to update their researches in the field of crowdsourcing. Monetary rewards, communication and coordination, task understandability, and task documentation were found to have considerable impact on participation time in software crowdsourcing contests. The research opens the gate for futuristic research, seeking ways to formulate how crowd participation of web developers and mobile app developers is affected.

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LIST OF ABBREVIATIONS

CS	-	Crowdsourcing
CSD		Crowdsourced software development
SW CS		Software Crowdsourcing
SLR		Systematic Literature Review
OSS		Open Source Software

LIST OF SYMBOLS

α	-	Normalization symbol or smoothness factor
β	-	Normalization Symbol for link quality estimation

CHAPTER 1

INTRODUCTION

1.1 Overview

This chapter summarizes the introduction of crowdsourcing, software crowdsourcing platforms, and how participation time effects the crowd. Existing data shows that research area is not mature enough to serve the issues like, which factors effect participation time in software crowdsourcing to the required extent? So, research problem, aim of research, scope of research, Significance of research along with research questions are mentioned in this chapter. The outline of the paper has also been mentioned in the following chapter to state the flow of the thesis.

1.2 Background

Crowdsourcing is a working model that focuses on utilizing human intelligence to solve problems that computers alone cannot yet solve to the required degree. With a revolution in technology, crowdsourcing has gained increasing popularity as the Internet makes it easier to engage the crowd with the work. Crowdsourcing is regarded as a vast term that constitutes a wide range of topics like innovative ideas for new tools, approaches, skills, creativity and conceptual ideality of the crowd, which is used in the process of outsourcing work (including seeking ideas) to a large and possibly unknown group of people (the crowd), which are usually external to the organization (seeker) (Chiu, Liang, & Turban, 2014).

The online platform of random crowdsourcing allows requesters or seekers to discover new and hidden talent, in their respective fields beyond their organizational boundaries. Crowdsourcing platforms also allows the seekers to take advantages without any boundaries. Some of these advantages may include, financial help, time friendly nature, improved quality, and sharing of personal expertise. Crowdsourcing platforms play a key role in allocating the tasks to the solvers according to their capability, interest, and skill level. This can be carried out all around the technology world. Using widespread internet. Contest-based crowdsourcing platforms promote the sense of competition among the participant to find the best solution from many of the solutions provided by the complementing individuals. The most probable solutions are than accepted by the requestor or seeker (Ayaburi, Lee, & Maasberg, 2019).

The specialists in any field of software engineering, who involve in the development, up gradation, analysis or any other means of software project or system, are known as crowd (Malik & Khan, 2018). This is novel form of work, in which 'crowds' of people can cooperate and tie up to complete a different software task or variety of subtasks of one giant task (e.g., testing, bug fixing coding decoding) Crowdsourcing is an alternative to one unit software organizations, which are supposed to work in limited office boundaries. According to the expertise and interest of the participants, they registers their submission in order to compete with others contestants, but only the participant who submit the best quality applicable and workable solution wins the reward which can range from an appraisal note to a huge amount of money, it will later on be termed as financial work reward in this study.

A crowdsourcing contest now a days is one of the most renowned modes of crowdsourcing competitions. It is supposed to works as an advanced tool for a software organizational body to carry out an open innovation for the crowd. So they may choose the task announced, according to their mere interest, desire, experience skills and level of expertise.

The level of active participation by the crowd acts as one of the very unique source of the successful accomplishment of crowdsourcing contests (K. Yang, 2019). While as far as the level of performance, of a crowd is concerned, these contests are

mainly dependent on the level of lively participation of crowd and effort that they put in the submission of solution.

Online crowdsourcing contests are nowadays considered to be an alternative way for companies to innovate their products by utilizing less resources and opting the best solutions from experts outside of the four walls of the organization. Software Crowdsourcing (SW CS) is the meeting of a worldwide active and energetic bunch of online workforces who can be selected on-demand in order to contribute to various types of different software updating and development tasks like finding bugs, interface evaluation, critical analysis, expert reviews. Now a days the Crowdsourcing procedure is mediated by different online platforms that actively and instantaneously connect seekers with online Crowd of solvers.

The platform allows the seekers, who seeks for a feasible solution to his problems, the facility to spread tasks to many skillful volunteer workers, who consciously opt these problems, inspired by the reward (L. Machado, Kroll, Marczak, & Prikladnicki, 2016). The successful accomplishment of the task majorly depends on time that a participant spent on the assignment taken up by him. This time limit is called participation time of the crowd.

Participation time is termed as the average time consumed by the crowd between entry into an online crowdsourcing competition and its subsequent time taken for task submission. Participation time play key role in software crowdsourcing contest, task quality as well as task results, the time taken by single participant or many participants is an indicator of many solutions to the taken-up task.

These solutions than have the chance of having one of the best solutions for the identified task. This all depends on the participation time of the crowd and is the most important factor that effect the process of crowdsourcing (K. Yang, 2019). This is the major factor which decides whether the launched problem has gathered subsequent solutions by the participants or otherwise is rejected by the crowd. It also help in deciding the companies to continue crowdsourcing for their upcoming projects or to

figure out certain other procedures for the solution of emerging problems in future. Thus participation time act as a backbone in the process of crowdsourcing.

The phases of software crowdsourcing contest are shown in Figure 1.1.

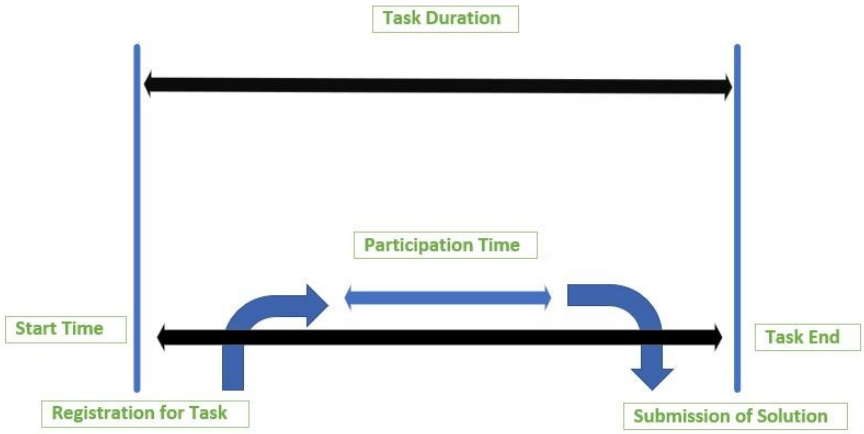

Figure 1.1: Phases of software crowdsourcing contest

The effort capitalized by a participant determines the quality of solution of the submitted task and then quality of this submitted solution will further have impact on the probability of winning. So it is summed up that the participation effort of the solvers is significantly connected to his probability of winning the reward. Software development tasks have certain common traits, it includes that they are often dependent, structured, heterogeneous, complex, interconnected. Software development tasks usually require noteworthy periods of participation time, cognitive skills and also need numerous types of expertise in the required field (de Souza, Machado, & Melo, 2020).

Task complexity often ranges from simpler one to most complexed level (Alabduljabbar & Al-Dossari, 2017). Tasks structure suggests to solver whether a task is well structured, it has well defined boundaries or unstructured, or limitless. Well-structured assignments are those for which the arrangements or crowd commitments are unmistakably characterized (for example assemble an organization site or bug fixing in the site, comment on a 2 hour video of interface evaluation,) Unstructured

tasks or complex tasks require innovativeness and creativity to comprehend them, they lack any characterized arrangement or approach (for example plan another item thought for an organization, make the best PC algorithm for a specific issue). Unstructured tasks often regularly include the improvement of creative thoughts or arrangements and are considered proactive(Nakatsu, Grossman, & Iacovou, 2014).

1.3 Problem Statement

The magnitude of performance which is carried out by participants of crowdsourcing contest primarily depends upon the participation time taken by the crowd and the amount of struggle imparted by solvers during the understanding, exploration, working and submission of described task (K. Yang, 2019). While The success rate in crowdsourcing contest depends on many factors like, solvers' aptitude, time investment, and familiarity with the problem (Mahr, Rindfleisch, & J. Slotegraaf, 2015). Existing studies are only helpful in the identification of the behavior of participants keeping in view their number of submissions. Still a very little work is done in the field of "time of participation" and how participation time affects the winning probability. Seekers have the intention to extract the efforts and ideas of participants, by using their participation time. participation effort is usually related with participation time of individual (Mahr et al., 2015). Participation effort is the time that they devote to perform the tasks. This study aims to analyze the factors that affect solvers participation time in Crowdsourced contest for software development tasks i.e. bug fixing, interface evaluation etc.

1.4 Aim of Research

This research work is mainly aimed to identify the factors that affects solvers participation time in software crowdsourcing contest. After preparing the list of the factors, this research will further be aimed to explore that, which of the identified factors significant effects on the workers participation time in have given task complexity. Thus, research is aimed to benefit the seeker to achieve better and high

quality results from participants in Crowdsourced contest for software development task.

1.5 Research Questions

Following are the research questions of this study.

i. What are the factors that affect the crowd participation time (effort) in software development tasks?
ii. In the given task complexity, which identified factors may impact on the crowd participation time (effort) in software development tasks?

1.6 Research Objective

i. To identify factors that affect participation time stated in literature.
ii. To investigate the impact of identified factors on crowd participation time according to task complexity.

1.7 Scope of research

This study significantly aims to work on crowd participation in crowdsourcing tasks and specifically focuses on the time factor. The scope of this research is to identify the factors that affect participation time in software crowdsourcing contest which helps the software production companies to post the requirements of these tasks interface evaluation and bug fixing on crowdsourcing platforms. These factors are collected by focusing on the academia knowledge presented in various researches which can be expanded in other directions in future. By keeping these identified factors in mind the task developers will be able to get better experience in gathering solutions from online crowd. This also owes an important value for software companies and organization to formulate the procedures that elaborates the ways to increase the

performance level itself through task design and the formulation of ways to attract more solvers to expand more participation effort.

1.8 Significance of research

The focus of this particular research work is online software crowdsourcing formats. The core aim of research is to put contribution in the desired field in the area of crowd participation and also the amount of effort put in by the crowd. Participation time depicts the behavior of a crowd. So the behavior of a crowd is assessed in a systematic study in this research. By carrying out SLR many factors have been identified that effects the participation time by the crowd.

These identified factors will prove to be helpful for the organization or the individual that seeks for any solution in crowdsourcing platform, by keeping in view the subsequent importance of these factor they may be able to formulate a package that will catch the eyes of its expert in one go. This will welcome many of the solutions for one specified task thereby increasing the chance for the best solution of the described issue. These factors will also help at an organizational level as they may encounter them and overall productivity and performance of the organization will increase to a greater extent. While documenting their online assignment they will design the query in such a way that it will attract more submissions by the crowd simultaneously decreasing the participation time of the crowd without altering the quality of submitted task. Current research will help industry practitioner and academicians to proceed the research in the respective field.

1.9 Thesis Outline

This thesis is structured in five different sections called as Chapters.

Chapter 1: The introduction of the research work being carried out is presented, along with this problem statement, is also described. The scope of study is narrowed down to certain specific objectives of study. Problem statement is designed according to these objectives that formulates research questions at the end of this chapter the scope of study along with its significances in the field and its contribution towards betterment of the existing field is discussed. Thesis is outlined at the end of first chapter.

Chapter 2 comprises of the review of existing literature in the crowdsourcing field. These existing studies will be explored to find out the conditions and factors that in a way effect the process of crowdsourcing that may be increasing, decreasing or halting the processing of the participants activity in crowdsourcing platform.

Chapter 3 will depict the research methodology being carried out in this research study. The methodology being used is Systematic Literature Review or abbreviated as SLR. SLR is used to explain the overall search strategy of the researcher, it also help in defining certain special selection criteria of research papers related to the scope of this study. In the end of this chapter expert researchers reviews are figures put along with opinion criteria of researchers regarding the work done.

Chapter 4 discusses about the Result obtained after conducting SLR. Factors being identified during SLR that effects significantly on the participation time have been described in details. These factors are thus narrowed down into groups on the basis of similarity in characteristics. The results of expert reviews has also been discussed in the subsequent chapter. At the end of the chapter analysis has been made and discussion over findings is carried out.

Chapter 5 it concludes the findings of the study. The conclusion is drawn on the basis of research work carried out during the course of study. Limitation of study has also been reported. Gate that study opens for futuristic works has also been reported in subsequent chapter.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview

This chapter presents the definition of crowdsourcing, software crowdsourcing, existing crowdsourcing platforms, and the identified factors which effect participation time in existing literature. In this chapter, literature review is briefly reported. The existing literature is presented in this chapter to further clarify the need of the said research.

2.2 Crowdsourcing

Crowdsourcing is a working model that mainly works on the principle of using the internet platforms to assign work to potentially volunteered online workers. This is done to increase innovations and creativity, by utilizing novel experiences of work force, or creativity of developer's, This is carried out by finding more creative ideas and solving tough and technical problems in a worldwide platforms which are not possible to be tackled in 9-5 office jobs. Jeff Howe was of the view that crowdsourcing has been proved to introduces a huge transformation in business field (Sahlins, 2009). In crowdsourcing environments, the relationship of platform with the workers and co-workers are violent, its short-lived and irregular (Murray-Rust, Scekic, & Lin, 2015).

Crowdsourcing term was first introduces by Jeff Howe in 2006 and was used to explain the method of extracting the wisdom of the crowd, by providing them with different types of tasks, and allowing them to accomplish them in a more creative manner (H. Sun, Zhang, Yan, & Liu, 2015).

Crowdsourcing support includes a huge variety of creative contests, and its prosperity is firmly identified with the quantity that's growing enormously, with subsequent increase in quality of solvers (Shao, Shi, Xu, & Liu, 2012).The area of software engineering which is based on crowdsourcing uses a unique and innovative method of the novel critical thinking model of crowdsourcing into software engineering area, which serves as a promising research region (B. Li, Wu, & Hu, 2018).

Crowdsourcing uses a collective culture to make and float content as assignment and to tackle issues through the creativity of crowd (de Souza et al., 2020). Most software crowdsourcing platforms support this unique and highly emerging software development method and have opted to work in the form of competition among the participants. Crowdsourcing model expects to use a diverse and magnified group of individuals to proficiently uphold the tasks, specifically those task which can only be addressed computationally by using significant efforts, on part of solver. This is made acceptable by online crowdsourcing community to provide proper apparatuses to users, and also to organize and maintain sub tasks of the original combined task, and last but not least making these tasks accessible to crowd participants (B & B, 2017).

Proper utilization of internet in an open, arranged and structured processes have transformed individuals from merely being a consumers of products services to an active, and more concerned prosumers (producers and consumers) (Jerzy & Wilimowska, 2017). Crowdsourcing if used properly, provides guarantee to software development companies that it will provide numerous advantages in programming advancement. This is because it openly harvests experiments from a huge population of crowd participants that is particularly valuable for developers who are willing to improve the nature, quality and even yield of their products (Zhao et al., 2020).

It is the process of putting together information based collaboration with and among dynamic individuals from the crowd. Which is proved helpful in motivating and urging them to make simpler advancement of open developments on crowdsourcing platforms. Software Companies can effectively flourish by utilizing integral assets of information carried out by crowd, This is by taking into account the imaginative capabilities and inventive capacities of the crowd during execution of an open advancement. It thus helps in measuring potential of crowdsourcing participants (Jerzy & Wilimowska, 2017).

2.3 Software Crowdsourcing

Software Crowdsourcing is huge platform that promises software companies to achieve their goals at significantly low cost at a global scale (Kittur et al., 2013).The Interest of masses in software crowdsourcing is increasing because of its high efficiency and low cost of tasks execution (S. Li, Chen, Shu, & Hu, 2017). Software Engineering is the area that further explored the crowdsourcing model for software development, they were searching for complementary and unusual solutions for solving different problems and software product inventory. (Santos Machado, Melo, & De Souza, 2019) Cost friendly, work efficiency, faster development ,new innovation and improved quality of work are the few basic and vital benefits of crowdsourcing(Kilamo, Rahikkala, & Mikkonen, 2015).

Software Crowdsourcing was a long and difficult approach, impeded by communication challenges in the past (Naik, 2017). Practically all software development tasks requires the services like engineering, designing, policy implementation, interface evaluation, maintenance, testing, bug fixing and documentation. All these areas can be publicly Crowdsourced in more convenient manner(Zhao et al., 2020). One of the crucially important component of software crowdsourcing is its diversity which makes it totally different from traditional software development (Naik, 2017). Software crowdsourcing has been applied into different domains, such as labelling of large database sets, translation and transcriptions of

textual information of different universal languages, creative and design based novel applications.

Software Crowdsourcing implies the open call format, in order to offer task to different software companies or to a large group of unrelated individuals .The crowd community than decides whether it will performs tasks by taking part into contests or not (Sarı, Tosun, & Alptekin, 2019). By far software engineering Crowdsourcing has been applied to numerous development areas, among them coding being the most popular one. As one of the popular crowdsourcing platforms like TopCoder allow projects to be announced into three categories as user interface task, design task and development tasks (Sarı et al., 2019). Unequivocally Crowdsourcing is one of the innovative and highly acceptable place for development of software in this era, Some high profile organizations such as NASA and ELi Lilly are hiring crowd for their projects via crowdsourcing platforms (Alelyani & Yang, 2016).

In Crowdsourced software development assigned tasks are more complex, interdependent and requires noteworthy amount of time, participation effort and submission rate, hence an enormous amount of expertise are required to accomplish the task requirements (Goos, 2020). Software development is procedure that starts with floating task within a group of developers it not only floats the task in local crowd but also global distribution of task in many spatially and geographically separated people through the internet, Because of the speedily increasing amount of development projects in software development crowdsourcing platforms, it is becoming much difficult for the software practitioners to find suitable project for them to work from a chunk of information on the crowdsourcing platform website page (W. Sun, Yan, & Khan, 2020).

Crowdsourcing thus needs proper documentation of the project that companies or seeker want the crowd to solve. Outsourcing any of the task to an undefined pool of online solver that work as crowd, in the form of an open call format over the Surface of internet through crowdsourcing platforms is termed as crowdsourcing (Sahlins, 2009). Leticia et al. (L. S. Machado, Steinmacher, Marczak, & Alegre, 2020) are of the view that Software crowdsourcing contest is an act of transferring software

development task externally from a requester to a potentially reliable but undefined large group of online crowd, in an open call format through a digital crowdsourcing platform .

With the passage of time, by the help of improved digital literacy and relatively cheaper data connections all across the globe, crowdsourcing has become more predominant (Lalit & Reddy, 2018). Wang et al.(L. Wang & Wang, 2018) In the contest carried out by software crowdsourcing development, there is also a tied up demand and supply relationship between requester who post the task and crowd workers who opted the task for solution. Razieh et al. (Razieh Lotfalian Saremi & Yang, 2015) Crowdsourced software development process is much complex in nature and highly dynamic in execution, it is much challenging to understand the dynamics of online workforce behaviors as compared with consolidated software development projects within a software company.

With the progress in the field of software engineering an improvement in digital literacy is needed and also a dire need of inexpensive data connections have been felt , in that case crowdsourcing has developed more predominant (Lalit & Reddy, 2018). In software Crowdsourced development process, poor understanding between crowd development skills and requirements for the assigned tasks results in production of subsequently poor quality task completion(Yu, Wang, & Zhou, 2019). Software development models based on the online crowd through contest and microtasking have drawn more attention of companies across the world, both in the field of autonomous developers and startup(L. S. Machado et al., 2020).

There seems to be a developing trend now in software development projects that requires stepping down of task into mini-tasks, which can be Crowdsourced to online workers in order to achieve rapid development and fast delivery of task solutions (Razieh L Saremi & Messinger, 2017). Due to highly dynamic and complex nature of Crowdsourced software development, it is often very difficult and challenging to understand the dynamicity of crowd participant's behaviors as compared with centralized, in house software projects development(Razieh Lotfalian Saremi & Yang, 2015). Development of software's is a knowledgeable activity. Now,

Open-Source Software (OSS) has substantially changes the understanding of development of software activities(H. Wang, 2016). In recent years, two software sourcing methods have been found to grip up the attention of software companies, owners and managers these includes crowdsourcing and inner-sourcing (Saito & Iimura, 2020). SW CS has three main working models upon which it relies these are peer production, competition modeling and microtasking. These models are based on how the online workers participates in the software CS tasks (de Souza et al., 2020).

2.3.1 Modes of crowdsourcing

Crowdsourcing is an advanced form of collective intelligence, the basic idea behind the story is that information processing can emerge from the actions of online groups of individual's participants. In this regard several collective-intelligence approaches have been applied to software development process(LaToza, 2019). Software crowdsourcing have different models i.e. Peer Production, Microtasking and competition. The pillars that carry Crowdsourcing Peers and their productivity level, the quality of competitions, and the dissolution of whole task into microtasking are considered to have important and unique differences. To carry out the comparison of crowdsourcing models. These dimensions are helpful in describing the range of models that works for crowdsourcing software development and engineering field. These models are shown in Figure 2.1

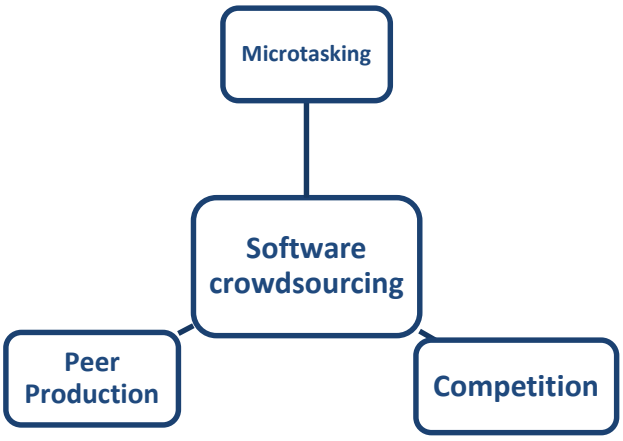

Figure 2.1: Modes of crowdsourcing

In crowdsourcing peer production model the contributions of crowd are taken up without any prize money and control of route is decentralized in this type of model. And contributors or participants, that are relatively a paying client, have the authority to decide the project's goals and scope. In peer production model participants are naturally motivated by the opportunity to gain expertise and knowledge with new technologies in software production, thereby helping them in improving their reputation and inculcating an approach to take part to a good cause.

A Second crowdsourcing model is microtasking, this model decompose task into a set of independent microtasks which can be completed in short time and by combining these solutions of micro tasks and elaborated solution is created for a more complexed actual task.

Another model of crowdsourcing is competition model, it has recently gained importance and wide place in Crowdsourced development. Competition models are very similar to traditional outsourcing, in which client requests the participants to work on task and pays for completion of task. However in competition model workers or participants are considered to act as contestants rather than collaborators. Contests with diverse input by the solvers are mainly regarded as popular for software development and are more welcomed.

2.4 Software Crowdsourcing contests

When contest is carried out in Crowdsourcing software development field it is considered as a model in which a seeker firm or organization requests any software based tasks and offers a reward for its solution by the crowd or solvers (Zanatta, Machado, & Steinmacher, 2018). In Crowdsourcing contests, the task, its description and specifications should be described very clearly in all defined aspects and all the related objects are supposed to be provided to the crowd prior to task launch. Any participant who would like to participate is welcome to join the contest (Sarı et al., 2019). R. Saremi et al (Goos, 2020) was of the view that task arrival with more than 70% similarity on formulation of solution will put negative impact on the level of task

competition and put a question mark on task creativity. In order to get the guarantee of having an effective task in Crowdsourced software development, not just it is important to have a higher competition level to pull in enough accessible qualified crowd, on the other hand it additionally demands an Excellency in having a good laborer versatility among various tasks.

Each participants of a contest provide an equally acceptable, Workable, competing solutions of task, then from these provided set of solutions the crowdsourcing platform selects one of the best and winning entry and the corresponding winner workers will be paid well for their solution. Many of the software workers use their own expertise and technology to seek participation in software development related tasks through the crowdsourcing platforms such as TopCoder, Amazon Mechanical Turk and Taskcn (B. Li et al., 2018). When the posted task is completed by the participants, Crowdsourced platform that is intermediate party has the authority to access the provided task by the solver and the seeker evaluates the quality of the work done. Then According to the quality level of the work, crowdsourcing requester makes payment to the collaboratively worked members or to the best solution submitted by the participants (Sarı et al., 2019).

Software crowdsourcing is generally structured around platforms that exploit a contest approach, however competition reduces collaboration among crowd and brings challenging environment among them (Santos Machado et al., 2019). The quality of the software is compromised by receiving any inappropriate task to improper or unsuitable crowd. but also causes overload on both the platform and the participants.(Tunio et al., 2017).

2.4.1 Software Crowdsourcing platforms

The SW crowdsourcing, platform provides roadmap for the coordination and management of different processes in both business and technical levels (L. Machado et al., 2016). SW CS platforms should be provided with complete, clear and consistent documentation about tasks. And also when documentation is not available on platform,

it’s the responsibility of platforms to provide some proposed mechanisms, that developers can use to ask questions to the seeker (Zanatta, Steinmacher, MacHado, De Souza, & Prikladnicki, 2017). During a SW CS, Crowdsourcing platform moderators play key role by providing support and guidance for crowd competitors, also removing misconceptions, getting the registered competitors which are aware of deadlines, clarifying requirements of task and, negotiating deadlines with the requestor or solvers are also the duty of CS moderator (Santos Machado et al., 2019). Competitive SW CS platforms intentionally reduce or minimize communication and collaboration among the participants involved (solver, platform, and seeker) while they take part and compete in the software Crowdsourced development tasks.

With the rapid and overnight expansion in the areas of software crowdsourcing platforms Software engineering does not only belongs to the group of developers and more rapid increase is observed in the amount of projects in software development crowdsourcing platforms, it is becoming more and more difficult for participants of contests to find the most feasible and suitable project for themselves to work from very less or bit of the information provided on the platform website page (W. Sun et al., 2020). SW CS platforms act as the marketplace between seekers (requester) and software crowd workers. Core need of such platforms is designing it such a way that it provides ease to crowd' understanding of crowdsourcing’s tasks, as well as to form relationships and practical communication between seekers and crowd(Razieh Lotfalian Saremi & Yang, 2015).

Most of the software crowdsourcing platforms give workers monetary reward for their participation in projects, like TopCoder (one of the largest SW CS), Amazon Mechanical Turk, Up work, Taskcn etc. (Alelyani, Mao, & Yang, 2017). Crowdsourcing platforms itself go about as third person making requesters and took solvers as the first person. However, most platform administrators focuses more on giving highlights to the facts that proves advantageous for requesters, since they are the clients of the assistance. By far, crowdsourcing platforms expect to help requesters in three principle perspectives: (1) dealing with the crowdsourcing participant mass force, (2) decomposition of the actual task and formation of the microtasks, and (3) handling of the microtasks so it can rejoin to make a complete whole (B & B, 2017).

2.5 Participation time in Software crowdsourcing contests

Razieh L et al. (Razieh L Saremi & Messinger, 2017) Participant's effort is measured by the number of days that he took between his registration for the task and his solution submission date. Task Price is one of the main and important key aspect to attract more crowd participation and contribution in software crowdsourcing, as most of the online workers took this platform as secondary source of income.(Alelyani et al., 2017). It is stated that more than 45% of software development participation or effort has been centralized on the maintenance for bug fixing in software development and maintenance task (Jiang, Li, Ren, Xuan, & Jin, 2018). Motivations level for user has direct impact on participation time, this can offer the first hints about what kind of features will be most required during the accomplishment of the task (Estuar et al., n.d.). In a study that was conducted back in 2014, motivation of user was a critical aspect of participation in software development. It was investigated that suggesting any approach that involves formation of user engagement during task development plays a key role in improving project results (Estuar et al., n.d.).

By and large, participants will in general seek to upgrade their own utility factor to register for a task It is investigated and found out that specialists are more prone towards opting and working in comparative tasks as far as monetary prize, content, technology, and complexity level is considered afterwards (Goos, 2020). Motivational Factors are divided into two following categories based on diversity of software crowd participant in crowdsourcing contest: Intrinsic and extrinsic factors. Incentives can be both intrinsic as well as extrinsic (monetary reward). It is contended that intrinsic incentives' shows up more beneficial outcome on the result's quality than the extrinsic ones (Nassar & Karray, 2019).

2.6 Existing Studies

Software Crowdsourcing contests have become proved to be significant and prevalent with the steady and fast facility of the Internet around the world. An efficient, well-structured crowdsourcing competition is not possible without the profound

comprehension of the factors that puts on some effect on people's constant investment of effort and their performance (Khasraghi & Aghaie, 2014). Researcher originates many studies as shown in Table 1.1.

Table 2.1: Existing Studies

Author/Year	**Domain**	**Contribution**	**Limitation**
Keng yang ,2019 (K. Yang, 2019)	Software crowdsourcing contest	Effect of task design, description, process and Environment was studied, It was concluded that high task reward attracts larger participation time in contests.	Research focused on logo designing task. Identified the relationship between four general predefined factors, ignoring other factors.
Xuan Wang, .et.al /2019 (X. Wang, Khasraghi, Schneider, & Contests, 2020)	Participation in Crowdsourcing Contests	Identify the factors influencing individual's sustained participation in Crowdsourced contest.	Data collected from only one platform, Kaggle. Generally discussed the individual participation, but not discussing the time and effort of crowd.

Haniyang Qi et.al / 2021 (K. Yang & Qi, 2021)	Participation in Crowdsourcing contest	Monetary reward, skill enhancement, work autonomy, enjoyment, and trust were found directly proportional to participation time.	Studied the influences of perceived costs and benefits on solvers' participation in crowdsourcing.
Haichao Zheng, et.al /2015 (Zheng, Li, & Hou, 2015)	Crowdsourcing Contest	Intrinsic motivation was more important than extrinsic motivation in inducing participation in crowdsourcing.	Research only discussed the crowd participation in the context of motivation, leaving other aspects.
Dan Li & Longying Hu /2017	Participation in Crowdsourcing Contests	Investigated the effects of influencing factors on solvers' participation in crowdsourcing contest. Task reward positively effect on	Data is collected from the Chinese crowdsourcing website Taskcn. Research is limited only on participation behavior in context of reward and competition intensity.

		participation. And contest intensity negatively effect on participation.	
Hua (Jonathan) Ye , Atreyi Kankanhalli / 2017	Participation in Crowdsourcing	Contributions of this paper is that the monetary reward, skill enhancement, work autonomy, enjoyment, and trust were found to positively affect solvers' participation in crowdsourcing. Comprehension effort effects negatively solvers participation in crowdsourcing.	In this Study focus is on only one type of crowdsourcing platform. Studied the influences of perceived costs and benefits on solvers' participation in crowdsourcing.
Dominik Mahr & Aric Rindfleisch & Rebecca J. Slotegraaf/2015(Mahr et al., 2015)	Crowdsourcing Success	Investigation on innovative versus thoughtful problem-solving styles on solving success, results shows that both styles can be effective but their success depends	Research is limited only two solver styles innovative versus thoughtful, leaving other factors.

		on the solver participation time and understanding with the problem	

Research community have carried out many studies related to online software crowdsourcing contests. Kengyang et al. [(K. Yang, 2019)] In 2019 has carried out a study over the factors that affect participation time of individual. He find out that participation time get effected by task design, its description, it's processing and the environment of the task explained are some of the factors that directly influence the participation time in crowdsourcing. According to him factors that highly influence the rats of crowd participation and submission rate is considered to be high task rewards. Task that pays off high rewards on completion of task attracts more individual attention and subsequently require less participation time without effecting the quality of task performed. Limitation of his study was that, it only incorporate research papers from Chinese platform of software crowdsourcing 'taskcn' this study also focuses on designing of the assignment to be launched on crowdsourcing platform.

According to the study which is done by another author anticipates that task incentives that are higher can get to be paid-off by best and higher number of participants performance and effort such as more online worker registered on platform, more submissions rate, innovative ideas and quality solutions will be met. However higher incentives do not always improve the number of submission for task in software crowdsourcing, and this shows that it is necessary to modify the task reward amount for attraction of crowd. Moreover higher incentives for task can improve the internal code that is measured by bugs in the code (L. Wang, 2019).

According to another study under competitive environments, self-reliance demonstrates a positive correlation on effort of participants which in reply puts on positive effects on performance of the solver. While in noncompetitive circumstances self-reliance puts on a much negative effect on participants and afterwards on performance. Results shows a recursive relationship among self-reliance and

performance of participant, due to this performance affects self-reliance positively. Therefore persuading a sense of competition through monetary reward helps to improve the team effort and performance. Mediation of team motivation in effort and self-reliance relationship is also tested which results found that relationship is mediate partially by motivation (Dissanayake, Mehta, Palvia, Taras, & Amoako-Gyampah, 2019) .It is significant and vital step to allow software crowdsourcing providers to design platforms that will inspire the seekers and participants to perform better.

In another study Author proposed the model of the factors that influenced the amount and nature of participants according to the contest qualities and market competition condition has been developed. Data from crowdsourcing website in china is used to test the model. The outcomes of the study shows that higher monetary awards, easier task, longer duration to solve task and lower competition intensity among the participants will eventually leads to a greater number of solvers. Competition intensity and market value for other contending projects don't show huge connection with the capacity level of winner. However, higher monetary awards, longer task duration, and higher complexity level of tasks lead to higher capability level of contest winners (Shao et al., 2012).

In 2017 (Ye & Kankanhalli, 2017) a research was conducted which proposed that the monetary reward for solution, skill enhancement ,work autonomy ,enjoyment and trust were found to effect positively on solvers participation in crowdsourcing contest however comprehension effort have negative effect on solvers participation in crowdsourcing. Thus, this research paper contributes to the literature by identifying and empirically validating unique contextual motivators for participation in crowdsourcing. This study focus on only one Chinese crowdsourcing platform Taskcn.

In this study author explores the factors that affect individual's constant participation in online crowdsourcing contests. An empirical study is being conducted by using data from an online crowdsourcing competition platform, kaggle. Through which it is found that contest duration, previous performance, award amount and number of participants have noteworthy consequence on individual's sustained participation in crowdsourcing contest. This exploration add contributions by

recognizing the different factors influencing individuals continued participation in crowdsourcing contests that have both collaborative and competitive components (X. Wang et al., 2020).

Several studies have identified that crowdsourcing contests as well as participation time are correlated. However, there exist some gaps. First, studies of contestants' motivation are focused on extrinsic motivation such as winning monetary awards. To our best knowledge, no study has systematically examined the participation time of crowd in software development tasks like bug fixing and interface evaluation in software crowdsourcing contests. To fill these gaps, we are aiming to analyze the factors from literature that affects solvers participations time and effort in Crowdsourced contest for software development tasks. I.e. bug fixing and interface evaluation.

CHAPTER 3

Research Methodology

3.1 Overview

In this chapter the methodology of research will be discussed, which is used for timely conduction of this research. These are systematic literature review and expert review. The chapter also discussed the theoretical description of data collection methods to validate the research process. For conducting SLR a guideline by Barbara kitchenham is followed. In SLR inclusion, exclusion criteria, and quality assessment of the research papers is also done for perfection and validity.

3.2 Research Methodology

The collection of Information, its assessment and its assimilation is carried out by keeping in view certain defined sets of procedures or techniques in the area of research methodology. To accumulate concerned information within the desired space of research study, specific tools like Survey method, Experts interview and specially designed questionnaire are carried out which are further performed by utilizing specific tools.

3.3 Research Design and Procedures

The overall research methodology which is carried out in this research is outlined in four steps in figure.3.1.

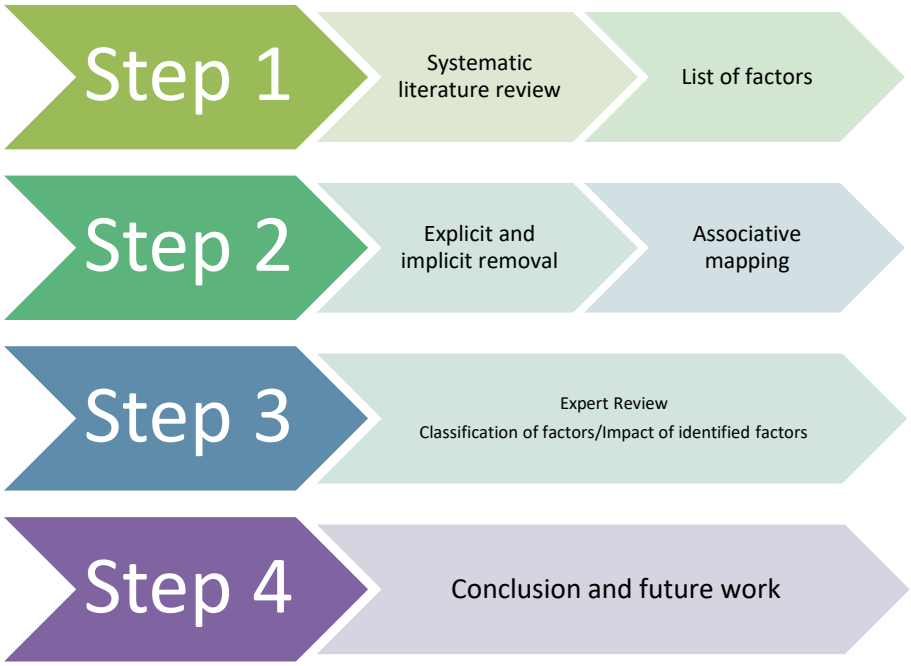

Figure 3.1: Research Methodology

The very first step of research methodology is Systematic literature review (SLR) and this procedure has already been described and reported in the ongoing chapter. Then the second step of research methodology is the setup to gain reviews of expert in this field. Output of first step is extraction and enlisting of numbers of factors which are further analyzed by and got validated from experts in the second step.

Expert reviews and all the analysis are well discussed and reported in chapter 4 of this paper. This discussion is based upon the data collection and analysis step of this methodology. At last as a final step, i.e., in step 4 results are concluded, limitations of the research are reported and in future, further work that this research report may supposed to leads are discussed.

3.4 Systematic Literature Review

Systematic Literature review is a structured methods for recognizing, evaluating and interpreting all accessible and available authorized work relevant to a specific research question, theme, region, or wonder of interest(Ferreira Barcelos & Travassos, 2006). It can be claimed as the well-organized form of secondary study on a universally acceptable work that is carried out by using a well-defined methodology in the process of identification, analysis and understanding of all available evidences which are in one way or the other related to a specified research topic, objective or a question, in a way that is clear, objective,, unbiased justified and repeatable with concurrent result. A systematic literature review tends to synthesize already carried out or existed research work in a well-organized manner that is fair or at least seems to be fair with high reliability and validity (Kitchenham & Charters, 2007). Fig. 3.2 gives a comprehension to the steps that a systematic literature reviews follows.

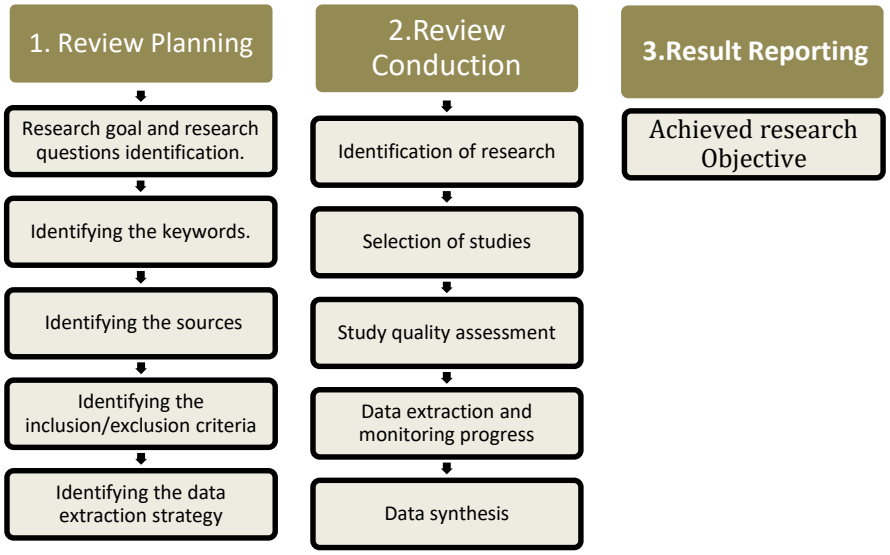

Figure 3.2: Overview of SLR steps

In order to get authenticated facts for the need of identification of factors for software crowdsourcing contest, a series of steps are needed to be followed to extract information from existing literature. The search methodology must be organised and

Systematic enough that it should permit the fulfillment of the search to be evaluated. Specifically, it should be the quality of researcher who is playing out a systematic review, should bend over backward to distinguish and report research that doesn't uphold their preferred research hypothesis just as simultaneously recognize and reporting research that supports the ongoing study.

In this research author used SLR guidelines proposed by Kitchenham guidelines(Kitchenham & Charters, 2007) (2007) conducting this study. SLR steps were followed. That may include the well-defined research questions, following with the search string and databases, in order to explore relevant papers to be study and analyse, running a two-phase level of extraction methodology with the process of quality assessment checklists, followed by generation of the final list of primary studies and then synthesizing useful data through thematic analysis of paper recognized in primary study. For conducting a systematic review, Kitchenham describes diverse reasons.

We conducted the study to summarize knowledge expressed in the literature and identify factors affecting crowd participation time in crowdsourcing contest and in process of assignment of complex task which identified factors that have impact on participation time. Systematic reviews report their search procedure with the goal that readers can evaluate their thoroughness and the completeness and repeatability of the process with reliability. SLR depend on a characterized search procedure that plans to identify and then extract as much of the relevant literature as possible. The data identified with the conduction of this systematic review was dissected also, enlisted in an orderly survey protocol, permitting its review or repetition freely(Ferreira Barcelos & Travassos, 2006). During the conduction of this systematic literature review the following process was used.

3.4.1 Reasons for adopting SLR

Many of the reasons can be listed down to choose SLR as a research methodology in conducting research. Some of the following reasons are mentioned.

i. SLR proves very helpful in analyzing and reviewing the current study such as "identify the factors that affecting solver participation time in software crowdsourcing contests"
ii. The process may also be helpful for the identification of gaps within the research boundaries of the current studies that can be addressed further for the future work.
iii. The SLR methodology is helpful in identifying factors that affect participation time, so these factors can be used to contribute in future research activities.
iv. The SLR process allows a thorough review of the literature. The researcher can go deep into the knowledge expressed in papers and subsequently extract one that is corresponding with his study objectives.
v. It can also predict futuristic work related to existing study and thus open new Gateways for the upcoming researchers.

According to kitchenham guideline (Kitchenham & Charters, 2007) some of the important features of SLR as below.

i. It is very helpful in Improvement of literature review protocol, including research questions and generally search methodology.
ii. With help of SLR search strategy incorporates distinguishing proof of most extreme number of literatures contemplate relevant to investigation
iii. It has made the procedure easy for the documentation of the whole quest which is carried out and its subsequent outcomes for future studies.
iv. In the process of carrying out primary studies this methodology provides a very reliable and well-defined Inclusion and exclusion criteria.

3.4.3 Process of SLR

Systematic literature reviews is the procedure of reviewing paper in systematic manners so information required from the study can be taken up and extracted as requires. The conduction of study for literature review is a challenging process which can be carried out systematically by certain predefined steps, that makes the study easier.

The conduction of SLR methodology is completed in many steps. These steps are further divided into set of three phases. These include, planning of review, the conduction of review and finally reporting of the review. Guideline of kitchenham are followed for conducting Systematic Literature Review (SLR) (Kitchenham & Charters, 2007). To gather the results of the search in accordance with already defined research questions and problem statement, keywords are used. These words are helpful in the search and exploration process of different databases. Systematic review is mainly based upon the study design and the procedure to carry out proper, well organized Systematic literature review process. Which first of all inquiries and answer about the need of SLR.

The protocol is than develop for systematic study that includes research question, inclusion and exclusion criteria on the basis of which certain research papers are selected or rejected. And the way of analysis of the selected papers is prescribed. The major role of SLR is that it's very helpful in identification of primary study which is major step of protocol. After the development of a standardized study protocol, the next phase is review conduction. But the milestone in systematic research review is identification of primary study material. The overall process of review conduction development and subsequent analysis is carried out using the guidelines by Barbara Kitchenham.

3.5 Review Planning

Review planning is the first and foremost step in conduction SLR, in this step the planning is done about the procedure of execution of SLR. In the first place the need of conduction of research is figured out with the help of primary results in SLR. In the second step of planning research questions are formulated and presented in review protocol step. The protocol includes all the plans of SLR procedure.

During review planning step, the research motivation must be indicated by methods for characterizing what will be searched, the data sources where the search will be executed must be distinguished and the standards used to choose the studies

that will be carried out must be defined. Planning of review is an important step because in the initial stage of planning if the plan is not executed properly result authenticity falls at risk. And subsequently effects the research process. Toward the end of this progression, a version of the convention must be made and the feasibility of the review has to be evaluated. During the planning of this systematic literature survey, different decisions were taken relevant to scope and the purpose of their search.

3.5.1 Need for a systematic review

SLR helps in better understanding and validation of knowledge about the research being carried out. It is very important step in SLR conduction. SLR has helped us in identifying, analysing and summarizing the existing Literature regarding crowd participation. It also helps us to finalise our result without any biasness or prejudice.

i. Summarize existing research related to factor which affecting crowd participation time in crowdsourcing contest.
ii. Identification of research gap

3.5.2 Research Questions

We list our two research questions (RQs) to collect and synthesize the existing knowledge in software crowdsourcing contest and to identify factors that effects participation time in crowdsourcing contest.

i. What are the factors that affect the crowd participation time (effort) in software development tasks?
ii. In the given task complexity, which identified factors have impact on the crowd participation time (effort) in software development tasks? How task complexity mediate the effect of identified factors on crowd participation time?

3.5.3 String

A keyword search is a sort of search that center the coordinating records including one or more words portrayed by the author. These keywords need to recognize the most related examination among four scientific data sets, we characterized a few keywords and formulated them by means of logical operators AND and OR.

The process of extraction of search string combination according to research keywords is always considered to be the most crucial step which has to be carried out very critically. In the following research, the search strings are composed and formulated by keeping in view the objectives of Research Question (RQ) 1. To add to the clarification of research string further restructuring and updating is carried out by considering some synonyms and alternatives of the key words. Some of the terms that are commonly used includes Boolean OR and Boolean AND these terms are used to include alternative spellings i.e. synonym and antonym in order to carry out more words combination in first and second columns jointly. And the third column constitute the ids string. Carrying out the above mentioned procedure it is ensure that all possible combination of keywords and terms are encountered for research in electronic databases.

i. "Software Crowdsourcing contest "OR "Software crowdsourcing" AND factors OR constructs
ii. "Participation" AND software crowdsourcing AND "factors".

3.5.4 Data sources

In the process of review conduction search strategy has primary importance. This conduction can be carried out both manually or automatically on all available sources of literature i.e., Journals, Electronic Databases, or Reference list that can be extracted from primary data. The factor of biasness can be maximized by incorporating

all the positive negative or null results with in the subset of results. The process of search is documented and analyzed for further steps in SLR, The identification of primary base of study is carried out by following the search study process. The studies that resemble our search objectives were taken up from databases. And the process ling is done by using certain keywords. The databases selected for the extraction of Research papers were listed below.

i. IEEE Explorer
ii. ACM
iii. Science Direct
iv. Springer

Table 3.1 depicts some of the selected databases which are listed down to perform this SLR. It contains three columns, serial numbers, the list of databases and the URL's of each database is given against its name in the third column.

Table 3.1: List of Databases

Sr. No	**Database**	**Uniform Resource Locator**
1	IEEE Xplore Digital Library	https://ieeexplore.ieee.org/Xplore/home.jsp
2	Science Direct	https://dl.acm.org/
3	ACM	https://www.springer.com/in
4	Springer	https://www.sciencedirect.com/

Different online databases were incorporated while carrying on the said research work with the help of search string certain papers were opted in order to obtain the desired search results. These databases include IEEE, digital library, science direct, ACM are more often used.

3.5.5 Study selection Criteria

All the research papers that has certain keywords cannot be incorporated in the study. To meet the limitation and expectation of the objective of this study. Criteria for exclusion and inclusion has been set. On the basis of this criteria certain papers were selected and rejected to refine the search results.

3.5.5.1 Inclusion Criteria

i. Consideration of research work from past 10 years to make proceeding research work more relatable and authentic.
ii. Research articles or journals or conferences from well-known databases to avoid any discrepancy in research work.
iii. Research Articles must be in English language.
iv. Those papers are included which are discussing the factors related to participation time in crowdsourcing contests.
v. Either the title/abstract/keywords matches our area of research.

3.5.5.2 Exclusion Criteria

i. Research work other than English language will not be considered.
ii. Non-published research work are not included in this study.
iii. Keywords that are not related to particular research area will be excluded.
iv. Those research work which are out of scope of this study will be deducted.
v. Research publications will be excluded if their main focus is not participation time of crowd.
vi. Letters, editorials and position papers will all be excluded.
vii. Papers and reports will be excluded where only the abstract but not the full text is available.

3.5.5.3 Level of Inclusion/Exclusion

i. Level 1: In the first step research papers are skimmed based on their keyword the corresponding title of paper and the abstract.
ii. Level2: At the second level research papers that aids repetition are excluded from scanning.
iii. Level3: At this stage of research, full on research papers are studied based upon inclusion and exclusion criteria.

3.5.5.4 Study selection procedure

The major purpose of study selection procedure is the collection of accurate and to the point material for SLR. Study selection should also base on specific well-defined criteria. This specific criterion is elaborated in exclusion criteria for rejected study and inclusion criteria for including the study simultaneously. Study selection has gone through various procedure to make it rational and unbiased. These may include, the inclusion criteria must be based on title and abstract reading of specific paper.

Going further inside the process of criterion selection, certain distribution is considered which includes, the year of publication of Research paper, the author's description, the Papers language etc. These are considered to further specify and refine the procedure of selection of research paper a detailed quality-based assessment is also incorporated at the final step of implementation strategy.

The procedure for selection or deletion of research papers is performed by encountering the levels which are predefined in inclusion and exclusion criterion. All the Research papers are filtered by this criterion. Those which have passed the extraction procedure are farther suitable for research and were included in stream of systematic review of literature. Throughout all this process before finalizing the selection of research work for SLR, another checkpoint is prepared to be applied on the selected research articles which is called the quality assessment. The detail of criteria of quality assessment is listed below.

3.5.5.5 Evaluating the Review Protocol

It is much convincing to analyse, validate and use the reviewed protocol before its use in SLR procedure. The basic purpose of validation of research paper is to make the research free of any biasness and to make it highly acceptable based on its quality. Ketchum has the honor to propose the method of validating review protocol. In his prescribed method first, pilot search is carried out for identification of the core potential of these studies by the use of important keywords search string in different available resources. Furthermore, to make sure the validity of review protocol, it is verified by expert supervisors under whose supervision the research is conducted.

3.6 Review Conduction

During this step, identification of studies relevant to the goals of research and satisfy the selection criteria was carried out .This recognition is executed on the choose information sources, using the search strings that have been created based on the keywords defined on the protocol. The particular and relevant existing literature is removed by following three levels of data extraction approach. For first level of reflection in accordance with applying research strings, the data sets are referenced. The research paper thus acquired were studied by contemplating the title and conceptual level of the research paper.

Then For second level of data extraction approach, the abstract and conclusion of the selected research papers is surveyed to check whether it satisfies the previously mentioned rules of research properly. For the final data extraction level, after abstract and conclusion of the selected paper in level two discussion and analysis along with methodology of selected paper is investigated and used to prepare list of factors that affect participation time and participation effort of solver who generate the best solution for the task that solver picked from the different software crowdsourcing platforms.

3.6.1 Level of extraction

In the first step of SLR, four databases have been searched using the two search string. After collecting the search results 169 metadata information (Abstract, title, keywords) has been recorded. In this first filtering, duplicate and irrelevant papers have been removed from this list. At the end of the first filtering 138 papers have been selected and 31 paper have been removed out of the list. Then second step, a pilot study has been initiated by the author. Each paper has been reviewed by author based on its metadata as abstract, keyword, conclusion information to filter out irrelevant papers with respect to RQs. at this step 108 papers have been selected and 30 research paper were found to be irrelevant. At the third level of extraction author review abstract, discussion, conclusion and methodology was investigated, by the end of last filtering 65 papers have been selected and 43 paper were subsequently removed from the list of data extraction by the end of third step. List of these papers is given in table 3.2.

Keeping in view the above search strategy, the first level of extraction of paper for selection procedure is carried out by applying exclusion/inclusion criteria. This criteria is supposed to check the terms which are subjected to the title of article, abstract of the research paper and keyword devised by the author. If any paper matches the criteria of first level in terms of the main objective of this research paper only then the paper is floated towards the second level of extraction, on the other hand it will exclude the stream of dataset for further processing.

On the next level of extraction, each of the selected paper is investigated for any repetition, if any repetition is incorporated then it is also sentenced to exclusion Then, after successful application of the second level, further third level investigation of research papers are carried out. In which the paper is given a thorough reading and scanning to be included in dataset.

Table 3.2 Level of extractions

Databases	**Total Search**	**First Level Extraction (Abstract)**	**Second Level extraction (Abstract+ Conclusion)**	**Third Level Extraction (Abstract + Discussion + Conclusion + Methodology)**
IEEE	63	54	45	28
ACM	35	31	23	13
Springer	65	49	36	20
Science Direct	6	4	4	4
Total	169	138	108	65

Table 3.2 represents the statistical findings of each level of inclusion/exclusion criteria being carried up. The initial number of research articles that were included in first search, is shown in second column. The subsequent database for each paper is also mentioned against them in first column. It is evident that the initial number of articles has been decreased to relative degree when the extraction of first level of inclusion/exclusion criteria is applied. Then extraction carried out by applying the second level of prescribed exclusion/inclusion methodology the research articles have been decreased down to 108 from initial count of 138. Finally, by the application of the last level of inclusion/exclusion criteria the final number of accepted research articles reaches to 65 of 108.

Thus in the end, in total 65 papers are selected for the last step of Quality assessment. This step is carried out to ensure the fair selection of articles. Which is carried out to remove all sort of biasness. To carry out the process of quality assessment a well-structured specified criterion is composed. This criterion and scoring levels are mentioned in Tablulated form. The subsequent scoring of quality

assessment is also tabulated along with prescribed criteria for quality assessment in Table 3.4.

3.7 Quality Assessment

According to Kitchenham guideline, the quality assessment means the careful assessment of chosen literature to investigate its authenticity, validity, reliability, and relevancy. After sharing the literature with peers, it is being examined that whether the literature being collected is relevant to the research problem? It was also sorted out that can it be beneficial in research area (Kitchenham & Charters, 2007). 65 Selected research papers were shared with peers for unbiased review. To skip those having distorted results. With this quality assessment technique to be employed the number of papers narrows down from sixty-five to, thirty four research papers. These papers were than considered.

After getting some peer reviews it happened that two more-paper related to participation time were found. Thus, these papers were also included in my research work and as a result, now the total paper reviewed have reached to thirty six. In terms of literature review. Few quality assessment question were given to peers with certain research papers to review them based on those questions. Those questions are given below.

Table 3.3: Question Answer Assessment

Sr. No	**Questions**
1.	Are the objectives of the study clear to both seeker and solver?
2.	Does the study promise to add value to the already existing literature?
3.	Are the threats to validity given and seems to be genuine?
4.	Are the limitations of study given and seems genuine?

5.	Are the results clearly stated, and demonstrate what they are supposed to demonstrate?

The assessment of factors was carried out based on scoring of question. The criteria of scoring ranges form 0-1.00. Scoring was so designing that those question which has score less than 0.60 were omitted and those which have value above 0.60 were selected. The assessment criteria with their score is given below in table 05 and based on this score a number has been allotted to the results collected from the peers' review.

Table 3.4: Assessment Criteria

Sr. No	Assessment Criteria
1.	Poor Quality = 0 Fair Quality = 0.33 Good Quality = 0.67 Excellent Quality = 1

Here is the response collected from the peer reviewer after review the selected papers for research purpose.

Table 3.5: Participants Response for QA Assessment

Participants	Sr. No. of Papers	Q.1	Q.2	Q3	Q.4	Q5	Score
P 01	PID 01	1	1	0.66	1	1	0.932
	PID 40	0	0.33	0	0	0.33	0.132
	PID 03	1	1	0.66	1	0.66	0.864
	PID 41	0.33	0.33	0	0	0	0.132

	PID 42	0	0	0.33	0	0.33	0.132
	PID 07	1	1	0.66	1	1	0.932
	PID 16	1	0.66	1	0.66	1	0.864
	PID 22	1	1	1	1	1	1
	PID 43	0	0.33	0	0	0.33	0.132
	PID 44	0.33	0	0	0	0.33	0.132
	PID 16	1	1	0.66	1	1	0.932
	PID 45	0	0.33	0	0	0	0.066
	PID 56	0.33	0	0.33	0	0	0.132
	PID 22	1	1	1	1	1	1
	PID 57	0	0.33	0	0.66	0	0.198
P 02	PID 17	1	0.66	1	1	1	0.932
	PID 18	1	1	1	0.66	1	0.932
	PID 65	0.33	0	0	0.33	0.33	0.198
	PID63	0	0.33	0	0	0	0.066
	PID25	0	0.33	0	0	0.33	0.132
	PID30	0.66	0.66	1	1	1	0.864
	PID32	0	0.66	0	0	0	0.132
	PID57	0	0.33	0	0	0	0.066
	PID55	0.33	0.33	0.33	0	0	0.198
	PID39	1	1	1	0.66	0.66	0.864
	PID59	0	0	0	0.33	0	0.066
	PID02	1	1	1	0.33	0.66	0.798
	PID50	0	0	0	0	0.33	0.066
P 03	PID04	1	1	1	1	1	1
	PID46	0	0	0.33	0.33	0	0.132
	ID 58	0	0	0.33	0	0	0.066
	PID06	1	1	0.66	0.66	0.66	0.796
	PID53	0	0	0	0.33	0	0.066
	PID52	0.33	0	0	0	0	0.066
	PID09	1	1	0.66	1	1	0.932
	PID10	1	1	1	1	1	1
	PID11	1	0.66	1	1	1	0.932
	PID 38	1	1	1	1	1	1
	PID 37	1	1	0.66	0.66	1	0.864

	PID 36	1	1	1	1	1	1
	PID 05	1	0.66	1	0.66	1	0.864
P 04	PID12	1	1	1	1	1	1
	PID 13	0.66	1	1	0.66	1	0.864
	PID 64	0	0.33	0	0	0.33	0.066
	PID 15	1	1	1	1	0.66	0.932
	PID 48	0.33	0	0	0	0	0.066
	PID 21	1	0.66	1	1	1	0.932
	PID 23	0	0	0.33	0	0	0.066
	PID 24	1	1	1	0.66	0.66	0.864
	PID 49	0.33	0	0	0	0	0.066
	PID 51	0	0	0.33	0.33	0	0.132
	PID 62	0	0	0	0	0.33	0.066
	PID 26	1	1	1	1	1	1
P 05	PID 28	1	0.66	1	1	1	0.932
	PID 29	1	1	1	0.66	0.66	0.864
	PID 61	0.33	0	0.33	0	0	0.066
	PID 35	1	0.66	1	1	1	0.932
	PID 31	1	1	1	1	1	1
	PID 14	1	0.66	0.66	0.66	0.66	0.728
	PID 54	0.33	0.33	0	0	0	0.132
	PID 19	1	1	0.66	1	1	0.932
	PID 20	0.66	0.66	0.66	0.66	1	0.728
	PID 27	0.33	0	0	0	0.33	0.066
	PID 33	0	0.33	0.33	0	0	0.132
	PID 34	0.66	0.33	0	0	0	0.198

After peers review scoring, of papers were evaluated paper with score more than or equal to 0.60 were included in study While paper having score less than or equal to 0.59 were excluded from the research frame of factor identification for participation time. This help in narrowing down the paper for literature review.

3.7.1 Data Extraction

During the process of data extraction from the pools of primary studies, work that is in continued form or even is in type of version has also been reported in this research paper along with the reference of their author to make extraction picture more precise and clear. The data extraction protocol consist of two predefined stages of analysis which are classified as, Preliminary analysis and secondary analysis.

The first stage of preliminary analysis is in actual carried out to extract the initial results within research extraction protocol. The core theme that underlays the process of preliminary analysis is to refine and then define the initial search of research papers that are in accordance with objectives of the ongoing research objectives. And to carry out this refinement procedure the searched articles are analyzed by thoroughly investigating their abstract, because abstract gives compact, clear and concise picture of the whole study.

For that matter a mere scanning of only abstract may help to decide the selection of research paper that are going well with the defined research questions of ongoing research. Along with this preliminary analysis also has another goal of providing the study a first stage of filter. That's helpful in refinement and extraction of desired research paper by the help of data extraction process. Further in the Next stage, secondary analysis is carried out on the output that is gained from preliminary analysis. In this analysis procedure the whole paper is studied thoroughly and analyzed at all levels of its heading and subheadings. The conclusions, results and findings in searched papers are skimmed very thoroughly and deeply.

3.7.2 Data Synthesis

Data synthesis is the step in which data is generated. This is carried out by recording and then summarizing the results of research reviews which is carried out in primary study. The obtained results which are gained through first step are simultaneously documented in accordance with research questions which have been

mentioned previously in the review protocol. By reviewing this it would be visible that the result obtained from each of the individual study differs subsequently from each other. To address this difference another methodology is perfumed which is called qualitative synthesis. It is carried out to gather the data which is produced in the first step of synthesis.

The main focus of data synthesis is to examine the results. Which are extracted after running both preliminary and secondary analysis. The results which are obtained from primary analysis is than reported properly for its documentation. These results than provides the satisfying answers to the proposed research questions. The available answer to these research questions are not from single source. Infact the formation of answers could be based upon more than a single sources.

All of those sources which contribute towards the formation of answers are recorded as document so that they can be available to be access anytime as references for future needs. Graphs, tables and other reference linked with studies any be used as sources. Thus the answers which are synthesized from these sources might than be highlighted separately as chart graphs and tables.

3.8 Review Reporting

By passing through the step of literature review, peer assessment the last step came out to be result reporting step, author after carefully analyzing the identified studies for the ongoing research conduction, build up the conclusion. The conclusion was in accordance with the Research Objective of the study, this research work thus has answered the research questions.

And helps in identification of those factors that are proved to affect participation time of solver in crowdsourcing contest. After reporting the results, they were validated by the experts review. Result were reviewed so that SLR produce validated reliable results for futuristic approach.

3.9 Expert Review

Expert review is the process of verification of result done through a set of chosen experts. Being very humbled those experts examines the gathered data, carefully analyse and validate it to form answer to the question being addressed in research. Technical questions are being asked by the experts of the relevant field (Ayyub, 2001). Expert review does not only help in authenticating the identified factors but also help for discovering research gaps, loop holes in this study and by the end collaborating useful suggestions. This research after conduction of systematic literature review validates the data through expert review.

For expert assessment conduction guideline by Ayyub has been used (Ayyub, 2001).Experts' selection is done on the basis of their research interests, experience in academia or tech-sector. Once experts have validated the data collect their response is recorded and presented in the research paper with reference.

Given below is the standardized criteria for experts' selection.

i. An expert must have relevant experience of the field.
ii. An expert must have the basic knowledge of the question being discussed in the research paper.
iii. Expert From computer science and software engineering.
iv. Experts having academic and software industry experience.
v. Availability for research process.

This research paper enlists the list of factors that will affect crowd participation time in software crowdsourcing. Systematic literature review has been applied on the extracted research papers, and through this process few factors were identified. Those factors are grouped based upon their attributes. For the authentication of gained factors expert review has been conducted and the criteria for the selection of relevant experts is given above. This approach resultantly has helped in extracting a useful model based upon factors effecting crowd participation time.

Figure 3.3 given below is the figure showing the steps to conduct expert evaluation.

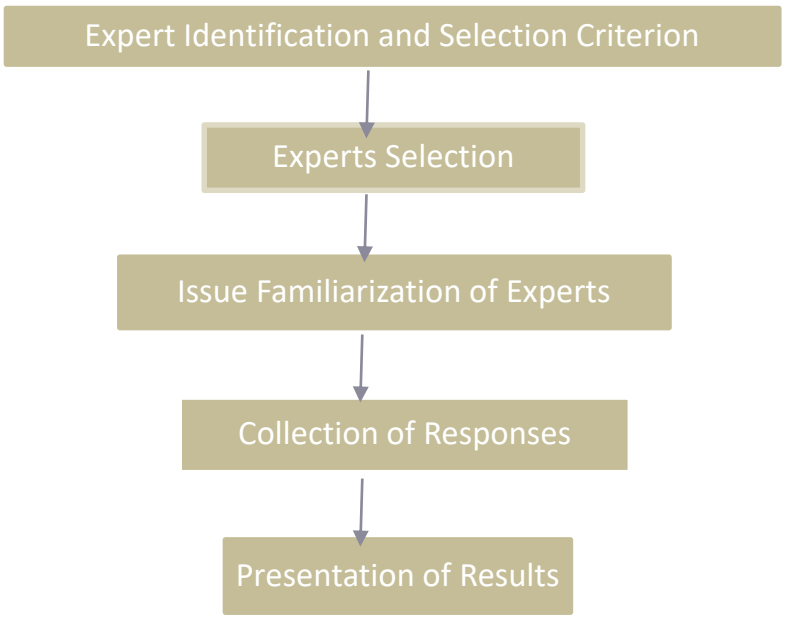

Figure 3.3: Steps to conduct expert evaluation

CHAPTER 4

RESULTS AND ANALYSIS

4.1 Overview

This chapter demonstrates the findings which are gained, following the research methodologies in the form of results. For second phase of research conduction, considering expert review, a number of academicians and experts from industry are chosen to validate the results gained from SLR which identifies the factors that have impact on software crowdsourcing participation time.

4.2 SLR Execution

In the said research, SLR is used to identify the factors that can affect the participation time of participants in crowdsourcing contest, In SLR methodology the level of work and knowledge reported in any research paper, which is related to any research area, is extracted for analysis. In this study, expert reviews are used to evaluate the validity of identified factors that affect participation time. In the chapter 3rd of this study the protocols of SLR and Expert review have already addressed. In Chapter 3, the detail description of each step of SLR is presented. After the collection of appropriate research articles an already defined inclusion/exclusion criteria is applied on them.

4.3 Data Units identification

In the process of SLR execution protocol, the process of ensuring quality assessment has been defined. Only 36 studies were found to fulfill the defined criteria of quality assessment and those 36 studies were than selected to be further reviewed, analyzed and added in this research process. The year of research ranges for 10 years, from 2009 to 2019. Articles are taken from known famous journals and conferences. After the collection of appropriate research articles an already defined inclusion/exclusion criteria is applied on them. Further a checklist was made to carry on quality assessment of the selected articles.

This list was formulated by the help of peer review. The processed data of all 36 studies is elaborated and tabulated below. From each paper some factors have been identified which are supposed to have some affect on the participation time of crowd, which in turn is the main focus of this SLR.

Table 4.1: Data units

Database	**Pre-level**	**1st level**	**2nd level**	**3rd Level**	**Post-levels selected articles**
IEEE	63	138	108	65	36
SPRINGER	65				
ACM	35				
SCIENCE DIRECT	6				
Total	169				

4.4.1 Factors Identification

Few of the factors are mentioned in this text, while rest of the factors are enlisted in the table no D in Appendix.

Table 4.2: Factors identification

Factor No	Paper_Id	Factors	Description
01	ID_01	collaboration skills	Communication among the Software crowdsourcing contest participants plays crucial role for well succeeded task
02		Task understandability	Clear Understanding of tasks for the crowd is very important.
03		Difficulty to manage personal time	Long and too much time taking tasks may result in lack of interest from the crowd to perform the task and produce less number of submissions.
04		Difficulty to find A task according to the participant abilities.	It is necessary for the participant to be resourceful in a certain technology.
05	ID_02	Monetary reward	Monetary award is one of the top motivating factors to attract crowd to participate in CSD contests
06	ID_03	Collaboration	Collaboration between crowd and crowdsourcing platform can Improve the quality and quantity of task solution and submissions in SWCS projects.
07	ID_04	Workflow design	An efficient design is needed that not only maintain flow of work but also has frequently of micro tasks.

By going through several steps of selection and deselection 36 studies that resembles the research domain of the ongoing article were selected for finalization. The 36 studies were found to have findings that are almost concurrent to the problem statement of this research work, which are gathered by SLR methodology. All these 36 studies were found to have different research methodology, ranging from survey, case study, to empirical study. Each study was of its kind and reviewed on merit by analyzing the context of the study, aim of study, research objectives or questions, and empirical confirmation of the research results selected research papers were than thoroughly.

In order to extract and maintain the list of factors that are required for the conduction of this research. The conduction of implicit removal provides 5 factors as a whole available by multiple researchers however, explicit search contributed 6 factors contributing in factors affecting crowd participation time in software crowdsourcing contest. Table of implicit and explicit removal is attached in appendix as table B and table C.

4.4.1.1 Explicit removal Explanation 1

In explicit removal, identified factors which have same name has been removed for example task detailing used in P_ID 17, P_ID 07, and P_ID 15 has been removed and used as a unique name “Task documentation”. Collaboration used in P_ID 03, P_ID 11, and P_ID 21 has been removed and used as a unique name 'Collaboration.

4.4.1.2 Implicit removal Explanation 2

In implicit removal, in certain papers some of the identified factors have same meanings, those has been removed and are merged into one whole. For example, factor like Difficulty to find a task according to the participant’s abilities and task worker compatibility have been removed and used as a unique single merged name Task Compatibility. Communication between solver and seeker and level of

coordination and communication has been removed. Instead a common name that merged the qualities of those is coined as" communication and coordination between seeker and solver."

4.4.2 After implicit explicit factors LIST

Following table 4.3 are the extracted factors post-implicit and post-explicit removal following the above mentioned methodology.

Table 4.3: After implicit explicit factors LIST

Sr.No	List of Factors	Sr.No	List of factors
1	Task documentation	23	Communication and collaboration b/w seeker and solver
2	Collaboration	24	Task Reward
3	Monetary Reward	25	Task Decomposition
4	Task Clarity	26	Task Management
5	Task Complexity	27	collaboration skills
6	Worker reliability	28	Workflow design
7	Task Accessibility to worker	29	Language Barrier
8	Self-motivation	30	Favorite games promotion
9	Quitting rate	31	Financial feasibility
10	Task Duration	32	Link count
11	Dedicated developers	33	Task scheduling’s
12	Higher task reward	34	Asynchronic behavior of task
13	Knowledge	35	Software innovation
14	Data security problem	36	Quality match productivity
15	Intellectual honorship or patent	37	Fund leveraging
16	Crowdsourced software quality		

17	Monitoring crowd during work		
18	Requesters with brand name		
19	Elaboration of tasks		
20	Platform usability		
21	Keeping participant motivate		
22	Task Allocation		

4.4.3 Grouping of factors

The assigned characteristic factors names' are then categorized with a unique group names. Individual group names with extracted essential factors are then further reviewed by experts who have Experience in academia or software-industry expertise, related to the discussed research problem and availability of the experts' criteria for the research process. Expert review is done for expert evaluation, assessment and verification of grouping done by the author. Extracted factors from literature were shared with experts'. Questions are being asked by them regarding objective, expected outcome of the research, resources used to extract information, methodology and base research paper. Extracted factors with group names and requirement as per demand are provided through email. Research question are shared with them to get the grouped verified along with below mentioned two key concerns.

i) Is the grouping of factors mentioned accurate?
ii) Are the factors having a suitable group name?

Table 4.4: Personal Details of Experts

Experts'	**Experience**	**Job Place**	**Email**
Expert 01	10	Bahria University	tamim@bahria.edu.pk

Expert 02	16	COMSATS University	Uzair_iqbal@comsats.edu.pk
Expert 03	8	Narjan University Saudi Arabia	maasghar@nu.edu.pk
Expert 04	9	Brno University of technology-Czech Republic	goni@vutbr.cz

Mentioned above is the list of Experts, which have been consulted for their kind review on the ongoing study. Experts were chosen on the basis of their experience in the field of CS. And all of them were found to be humbled enough that they gave detailed study to the factors identified and expressed their views in comprehensive forms. Which are further encountered in this study for the validation of results gained through SLR method.

Table 4.5: List of Grouped Factors

CAT. NAME	FACTORS	Views of EXPERT 1	Views of EXPERT 2	Views of EXPERT 3	Views of EXPERT 4
Reward	• Monetary reward • Task reward • Financial feasibility • Fund Leveraging • Higher Task reward	Financial components may be grouped separately or task reward may be renamed as financial task reward	Agreed	Agreed	The category and factors are appropriate
Task Oriented	• Task complexity • Worker reliability • Task compatibility • Task Decomposition • Task Management • Task Duration • Task scheduling • Asynchronic behavior of task	Worker reliability is out of place here.	Remove worker reliability, after removing worker reliability it is added to personal motives	I am confused about 'worker reliability' if you have a strong justification about it then keep it, otherwise remove this.	The category and factors are appropriate, maybe you can consider task quality, scope and risk.
Coordination & communication	• Collaboration • Communication b/w solver and seeker • Collaboration skills	Agreed	Agreed	Agreed	Collaboration factor here seems very general. It should be more specific and control evaluate please refer to stakeholder engagement principles.

Task Understandability	• Elaboration of task • Link count	Agreed.	Agreed	I believe 'Task complexity' should must be in this category, but again, I would like to say if you have a justification from the literature ,please keep it in the category 'task oriented'.	Agreed
Platform Oriented	• Data security • Intellectual honorship or patent • Monitoring crowd • Platform usability • Software innovation	Agreed	Agreed	In my opinion, you can replace intellectual honorship or patent with "intellectual property" but if you have chosen this name from the literature, then keep it.	The category and factors are appropriate.
Task Allocation	• Task accessibility • Allocation of task	Can be combined with task understandability	Agreed	Agreed	I suggest changing the category to 'task management'.

Personal motivation	• Self-motivation • Quitting rate • Dedicated developer • Knowledge • Keeping participants motivate • Requester with brand name	Agreed	Self-motivation and keeping participants motivate can be treated as same.	Agreed.	Personal category can be renamed into human resource, knowledge can be considered as skills and knowledge. Quitting rate can be renamed into turnover rate
Documentation	• Task Documentation • Workflow design • Language barrier • Task clarity	Agreed	Agreed	Without strong justification do not place 'task clarity under documentation category. Please have a look on literature and check can we fit it in task understandability.	The category and factors are appropriate

After expert review, the extracted factors were grouped using associative mapping technique. Associative mapping enables the researchers to group or sort the extracted content under a category according to their meaning and semantic. It is one of the most powerful technique of mapping in qualitative research (AQR, n.d.).

Table 4.6: List of Grouped Factors after Expert Review

Reward/ Money	**Task Oriented**	**Coordination & communication**	**Task Understandability**
Monetary reward	Task Decomposition	Collaboration	Elaboration of task
Financial Task reward	Task Duration	Communication b/w solver and seeker	Link count
Financial feasibility	Task compatibility	Collaboration skills	Task accessibility
Fund Leveraging	Task scheduling		Task complexity
Higher Task reward	Task Management		Task clarity
Platform Oriented	**Personal**	**Documentation**	
Data security	Self-motivation	Task Documentation	
Intellectual honorship or patent	Turnover rate	Workflow design	
Monitoring crowd	Dedicated developer	Language barrier	
Platform usability	Skill and Knowledge		

Software innovation	Keeping participants motivate	
	Requester with brand name	
	Worker reliability	

4.5. Expert opinion 2:

The categories of factors that were made and applied on two tasks to investigate the impact of factors on participation time on crowdsourcing contests. Bug fixing refers to the identification and fixing of errors. The second task was to evaluate interface and in which user interface evaluation refers to the ease and effective services provided to the user to make a product more usable. Another functionality is to identify problems in usability of interface and to collect information to satisfy and improve user experience. For that purpose, six experts have been chosen and a brief overview was given to experts to investigate the impacts of factors. Experts assigned a weightage to these factors. Response collected from experts is mentioned in the given below table.

Table 4.7: Personal Details of expert

Experts	Experience	Job Place
Expert 01	10	Bahria University
Expert 02	8	Narjan University Saudi Arabia
Expert 03	9	Brno University of technology-Czech Republic
Expert 04	08	kicsit Kahuta
Expert 05	13	Szabist Islamabad
Expert 06	10	IUB

Task: Bug Fixing

The elimination of software errors is called bug fixing. A bug fix (T2informatik, 2020) is the result of a bug removal, bug fixing is the activity of fixing bugs. A bug fix is a change to a system or product designed to handle a programming bug/glitch. Many different types of programming bugs that create errors with system implementation may require specific bug fixes that are successfully resolved by a development or other IT team.

C1=Reward/Money, C2=Task Oriented, C3= Communication & coordination, C4=Task Understandability, C5=Platform Oriented, C6=Personal C7=Documentation

1. V.L= Very Low
2. L= Low
3. M= Medium
4. H= High
5. V.H= Very High

Table 4.8: Expert Review about impact 1

Experts	C1	C2	C3	C4	C5	C6	C7
	5 4 3 2 1 V. H H M L V.L	5 4 3 2 1 V. H H M L V.L	5 4 3 2 1 V. H H M L V.L	5 4 3 2 1 V. H H M L V.L	5 4 3 2 1 V. H H M L V.L	5 4 3 2 1 V. H H M L V.L	5 4 3 2 1 V. H H M L V.L
R1	5	4	3	5	2	2	5
R2	5	4	4	4	3	2	4
R3	4	5	4	5	2	3	5
R4	5	3	5	5	4	2	5
R5	5	4	4	4	4	3	4
R6	5	4	2	4	3	2	5
Total	**29**	**24**	**22**	**27**	**18**	**14**	**28**
Avg.	**4.83**	**4**	**3.67**	**4.5**	**3**	**2.33**	**4.67**

Task: Interface Evaluation

Human-Machine Interface Also known as the user interface, it is the medium through which the system and user exchange and exchange information. The slogan "user-friendly" appeared in the mid-1980s. This slogan (Fang, 2018) is translated into the concept of "usability" of the human interface. And become one of the key metrics for measuring the user interface. Usability is the degree of effectiveness (Effectiveness), efficiency (Efficiency) and user satisfaction (Satisfaction) of a particular product when it is used for a particular purpose in a particular environment.

C1=Reward/Money, C2=Task Oriented, C3= Communication & coordination, C4=Task Understandability, C5=Platform Oriented, C6=Personal C7=Documentation

1. V.L= Very Low
2. L= Low
3. M= Medium
4. H= High
5. V.H= Very High

Table 4.9: Expert Review about impact 2

Experts	C1					C2					C3					C4					C5					C6					C7				
	5	4	3	2	1	5	4	3	2	1	5	4	3	2	1	5	4	3	2	1	5	4	3	2	1	5	4	3	2	1	5	4	3	2	1
	V.H	H	M	L	V.L	V.H	H	M	L	V.L	V.H	H	M	L	V.L	V.H	H	M	L	V.L	V.H	H	M	L	V.L	V.H	H	M	L	V.L	V.H	H	M	L	V.L

R1	5	5	4	5	2	4	5
R2	5	4	5	4	3	4	4
R3	5	5	4	5	2	3	5
R4	5	4	5	5	3	2	5
R5	5	4	4	5	4	3	4
R6	5	4	3	5	3	3	5
Total	**30**	**26**	**25**	**29**	**17**	**19**	**28**
Avg.	**5**	**4.33**	**4.16**	**4.83**	**2.83**	**3.16**	**4.67**

After putting values into the table, an average was calculated to investigate the factor having the highest impact and the factors with low impact. To clearly display the gained results, graphs has also been made with seven categories and the rate given by the experts. Result displayed by using Likert scale.

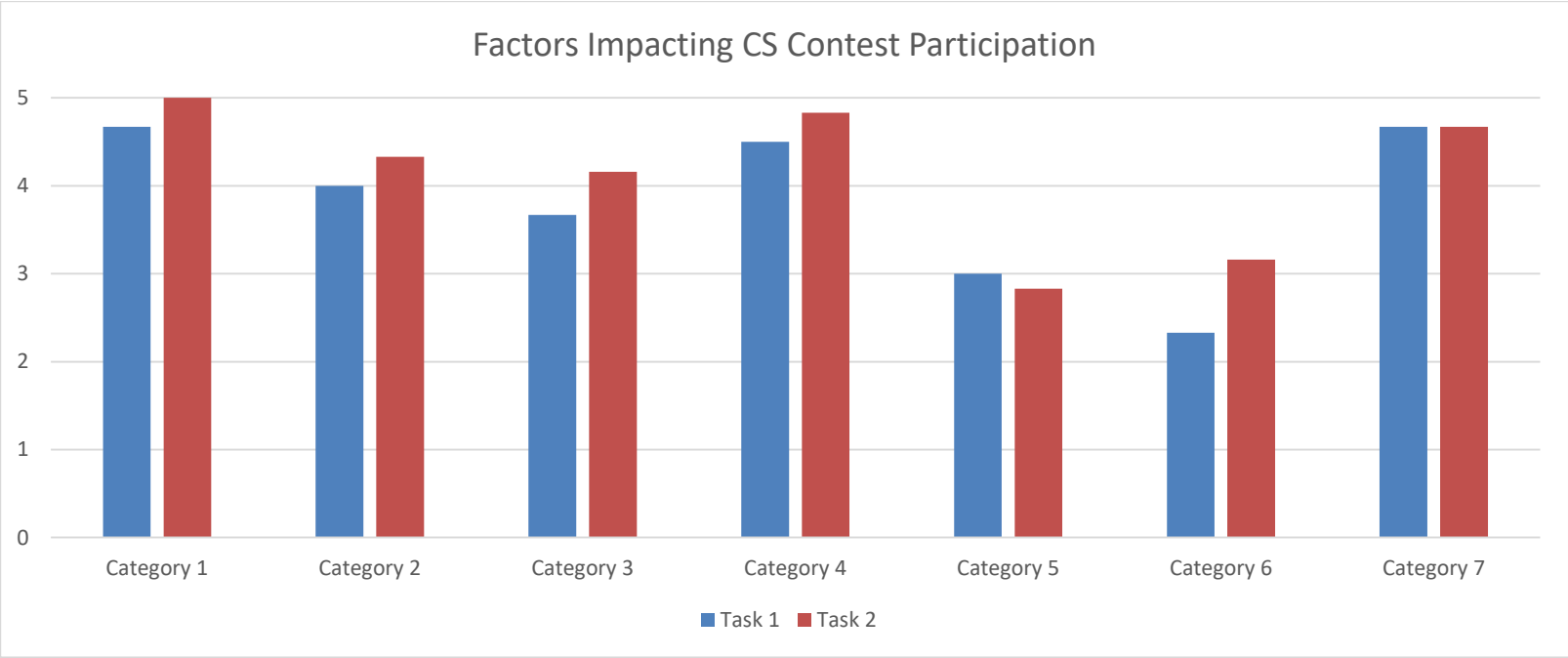

Fig 4.1: Tasks Mapping

It can be seen that category I that represents monetary award or money shows that crowd participation is having the most impact on participation time. The most the amount of task is, more is the chance of participation of people in order to win reward. The deeper analysis (Pilz, Gewald, Neu-ulm, & Informationsmanagement, 2013) reveals that society may see a larger trend towards crowdsourcing as mean of employment, as more and more individuals regard it as serious work and reliable source of income.

Secondly, the category having second most score is task documentation and task understandability reason because a task having the clear and easy documentation will increase the participation rate. The benefit is that it consumes less time and result is more effective which is why it is considered to be an important factor. Communication, coordination and personal factors are such categories that have medium score because of its medium impact on crowd participation. It is amongst those factors having less impact on crowd participation as compared to money or task understandability.

Platform oriented is having the least score given by experts due to their less impact on crowd participation, they thought these factors not having more impact on crowd participation in software crowdsourcing contest. There is the possibility these results vary if we take these factors into the industry and implement them on a real-time project.

4.6 Discussion

Crowdsourced software development uses an open call format to appeal geographically distributed online crowd participant to achieve and participate in different types of software development tasks according to their interest and skills(Mao, Yang, Wang, Jia, & Harman, 2015). In recent years most of the software development companies have revolutionize their working expel by the use of crowdsourcing model to get better solutions of their problems. In the whole process of crowdsourcing it is analyzed that the Participation time is a key factor for obtaining accurate and precise results. While working on participant's time many research articles (K. Yang, 2019)(Jian, Yang, Ba, Lu, & Jiang, 2019)(Zheng et al., 2011) are of the view that a key to success in any software crowdsourcing process is a keen observation of its participation time. The participation time works as an indicator, more you put in participation time it means more effort is encounters while working on a project there by increasing the chances of early and accurate accomplishment of the task.

While many Studies are of the view that rate of success is proportional to high submission rate which shows a high proportion of crowd interest towards the task. In this paper the factors that affect the rate of participation time are discussed, no matter if they increase, decrease or even halt the rate of participation time.

4.6.1 Money or Monetary Reward

Many of the research articles (Ye & Kankanhalli, 2017) (LaToza, 2019) are concurrent with finding that participation time is directly related to the Cost of Reward being paid by the task provider. Most of online worker seeks these platforms as secondary source of income. Thus they are more attracted towards task which pay high cost financial reward. Even though task may be complexed worker increase their participation time and produced improved quality of work in order to fight out the contest and walk away with the cost of work.

4.6.2 Communication and coordination

Communication and coordination (Razieh L Saremi & Messinger, 2017) are the other two factors that affect participation time in a software crowdsourcing task. A proper system of coordination (Mao, Capra, Harman, & Jia, 2016) between seeker and solver is a key to early completion of task, if the collaboration is not encountered while launching any task the participation time and rate of submission will consequently decrease. Because solver will find it difficult to understand the requirements of the task they a seeker wished to upheld. This barrier also comes up when the language of seeker and solver are different. This language barrier puts on a baggage to seeker and solver, they are not able to efficiently understand the requirements of one another there by affect the quality of submitted task and increase the participant's ambiguity level. This ultimately leads to low participation time.

4.6.3 Task oriented factors

There are certain factors that are task oriented they may get intense, as the task get complexed (Razieh L Saremi & Messinger, 2017). By Far Task complexity has proven to be one of the task oriented factor that directly effects participation time, more complexed task needs more time of crowd thus increasing participation time. Along with these workers compatibility to task is also task oriented factor if task is clearly explained with expertise level of solver it will be helpful for the solver to decide whether to opt the assignment or not. Thus he can decide to out his participation time on the task accepted. Task management on the other hand is also crucial factor. If the task is managed in a manner that it can be categorized into sub task and the expert of particular field can opt his particular kind of sub task the participation time increases also it will be accessible by many of the experts without altering the task submission quality will enhance.

Task duration is also a key factor that effects participation time. The Correct documentation of task (L. Machado, Zanatta, Marczack, & Prikladnicki, 2017) is so important factor to decrease the time taken by solver toward task accomplishment. Once a task is launched in clear and easy description it will automatically engage more solver and will take less time by the participants for solving the task. Thus a quality time will be spent by the solver on the task accomplishment. In this way participation time will be effected and also submission rate will be fruitful.

A clear description of the assignment (L. Machado et al., 2016)(L. S. Machado et al., 2020)(L. Machado et al., 2017)will also increase rate of task understanding by the crowd. And thus crowd will more prone toward choosing the word according to his needs, capacities, skill and level of expertise. When a task has been described in understandable manner it will attract more crowd towards itself and thus participation rate increases. Thus solver of the contest can decide to out his participation time on the task accepted. Task management on the other hand is also crucial factor in task oriented factors.

4.6.4 Personal Factors

Many of the personal factors (Saito & Iimura, 2020)(Y. Yang, Karim, Saremi, & Ruhe, 2016) have also been devised while going through the study, few of them topped the list, which may include Self-motivation level of crowd. If the individual is self-motivated he will not be effected by any monetary reward fame or up gradation. A self-motivated individual is always devoted to his work it does not need any outer factor to be compulsified.

prior knowledge of the crowd about task also plays an important role, if the solver has already experienced the task which has been assigned by the solver he will not be reluctant to take it up again and will also solve it in less time with more accuracy thus it directly increase the work quality and will require less participants time for the solution of particular problem. And dedicated nature of the developer also put a reasonable impact on the processing rate of crowdsourcing software field. It will even does not effect if participation time has to be increased because a self-motivated solver will keep on working for a more feasible quality based better result of the assigned task.

4.7 Academic and Practical contribution

The first and foremost contribution of this study is the identification of the list of factors which impose any effect on software crowdsourcing contests from literature. As a result we identified four categories of factors that are considered to have basic effect on the process these includes

Most of online worker seeks these platforms as secondary source of income. Thus they are more attracted towards task which pay high cost financial reward. Even though task may be complexed worker increase their participation time and produced improved quality of work in order to fight out the contest and walk away with the cost of work. Communication is a key to success in any work field. If the authority and

worker have the quality to communicate more often in understated manner it can bring marvelous result. Online Crowdsourcing platforms of provide an interface between solver and seeker for better communication it will definitely add to their level of performance.

More complicated task needs more time of solver to analyse understand breakdown synthesize and evaluate the work done. Thereby increasing participation time to many folds. But on the other hand if the complexed task has broken down into simpler sub task and is later on launched without compromising the quality of the work it will enormously decrease the work load on solver and thus his participation time will be minimum with maximum level of the hard work. Personal interest of the solver pays a very positive effect on the accomplishment of the assigned task. If the solver is innately devoted to his work it will increase the quality of work down to manifold and decrease the participation time without effecting the submitted work quality.

From systematic literature review it is examined that these factors can make software crowdsourcing contest more effective and convenient if are addressed in more precise systematic manner. The second contribution of this study was the validation and investigation of identified factors which have a huge impact on task complexity by conduction of expert review.

CHAPTER 5

CONCLUSION AND FUTURE WORK

5.1 Overview

This chapter sum up the literature review findings, analysis of research, results gained following the research protocol. It also covers the limitations, future work visions and conclusion of the presented research work.

5.2 Conclusion

In the past recent years crowdsourcing gained more and more attention universally, especially in software development industries .The Goal of the study was analysis of the existing literature on factors affecting participation time in software crowdsourcing contest and also which identified factors have impact on software development tasks bug fixing and interface evaluation by performing SLR and expert review. Based on thorough literature review these factors have been identified from 65 papers on three level of consideration basis. The factors were identified and then were critically analyzed by the reviewers and experts. Factors that got Score rate less than 0.60 were included. More emphasis was found to be on monetary benefits gained by the solver. Level of coordination between solver and seeker was also found to be important. Platforms like crowdsourcing are taken up by most of the software developers as a secondary mean to increase their income. Keeping in view their main motive if the cost or monetary reward is adjusting according to expectations of the

Solver it is more likely to attract more participants for the accomplishment of the Floated task. This will subsequently increase participation and submission rate on part of solver.

Task oriented factors like its description, documentation, task decomposition, task duration were also found to be very significant while attempting to find the effecting factors for participation type. Certain factors are platform oriented. They are effected by the platform that are used for process of crowdsourcing. These may include platform usability in monitoring the crowd. Some platforms are user friendly that provides an easy and rigorous interface to both solver and seeker, while certain platforms are not so efficient in bridging between contestant and contester.

Certain factors are Self-dependent to the working mass. Self-motivational level of solver, his dedication to work, his investment and availability throughout the journey of task accomplishment are the factors that vary from individual to individual. Prior knowledge of the crowd towards the basics of any assigned task also pays major role in success rate of the task. If the crowd already has some exposure to the task or have already gone through such tasks their prior knowledge will immensely effect early and accurate task accomplishment. It will also decrease the participation time of crowd without effecting the quality of task. While documenting the task its workflow design, pays an important role in guessing and judging task requirements by the seeker.

Language barrier also pays significant role in crowd participation, if crowd is unaware of the language of seeker, task clarity may get effected. A more clear detailing of the task in highly acceptable and understandable language will equally increase the chances of crowd to understand the task better and accomplished it according to need of the seeker. Data collected was validated by the experts thus it opens door for further work in future.

5.3 Limitation

No study is complete in all the regards, every study has an extent of limitations that may left because of time constrains, space issues, human constrains, Information mishandling etc. First, the literature review in this study is only subject to the software development Crowdsourced contests

However, the research was reviewed through academicians and industry experts to know the impact, it would be more interesting to get it implemented on a real time project in the software industry to check the accuracy of the results gained. Another limitation of this study is that articles of only four databases has been reviewed. Many other data bases are still open for assessment on the basis of behavior of crowd and their contesting behavior. In total the SLR method carried out can be expanded to these data bases thus more generalized data can be obtained.

5.4 Future Work

This Research provides a theoretical approach on how factors affect participation time in software crowdsourcing contests. Future research can study the influence of task design on solvers' participation behavior by controlling task difficulty. In future research, we can also assess the solver's perspective with respect to task complexity. In future, factors effecting the participation time in web-development and mobile application development in context of software crowdsourcing contest can also be consider. In future, these extracted factors will be implemented on the real time projects to get better results that will helps crowd participants to increase productivity.

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APPENDIX A

Explicit Removal

Table B: Explicit Removal

Factors	P_ID	After Explicit Removal
Task Documentation	ID_17,ID_07,ID_15	Task Documentation
Collaboration	ID_03,ID_11,ID_21	Collaboration
Monetary reward	ID_02,ID_22,ID_38	Monetary reward
Task Clarity	ID_10,ID_39	Task Clarity
Task Complexity	ID_10,ID_26,ID_39	Task Complexity
Worker reliability	ID_16,ID_05	Worker reliability

Implicit Removal:

Table C: Implicit Removal

Factors	P_ID	Factors	P_ID	After Implicit Removal
Difficulty to find A task according to the participant's abilities,	ID_01	Task worker compatibility	ID_05	Task Compatibility

Communication,	ID_08	Level of coordination and communication	ID_09	Communication and b/w seeker and solver
Money	ID_13	Task price	ID_14	Task Reward
Monetary prize	ID_19	Task Reward	ID_12	
Task Decomposition,	ID_20	Micro task decomposition	ID_17	Task Decomposition
Poor Task Management,	ID_18	Task Management	ID_15	Task Management

Table D: Factors identification

Factor No	Paper_Id	Factors	Description
01	ID_01	collaboration skills	Communication among the Software crowdsourcing contest participants plays crucial role for well succeeded task
02		Task understandability	Clear Understanding of tasks for the crowd is very important.
03		Difficulty to manage personal time	Long and too much time taking tasks may result in lack of interest from the crowd to perform the task and produce less number of submissions.
04		Difficulty to find A task according to the participant abilities.	It is necessary for the participant to be resourceful in a certain technology.
05	ID_02	Monetary reward	Monetary award is one of the top motivating factors to attract

			crowd to participate in CSD contests
06	ID_03	Collaboration	Collaboration between crowd and crowdsourcing platform can Improve the quality and quantity of task solution and submissions in SWCS projects.
07	ID_04	Workflow design	An efficient design is needed that not only maintain flow of work but also has frequently of micro tasks.
08		Task Accessibility	Wide accessibility of task to potential workers increase the likelihood of task completion on earlier basis.
09		Self-motivation	Self-selection by workers enables them to work more efficiently and whole heartedly.
10	ID_05	Worker Reliability	The success relies on large crowd of trustworthy software workers.
11		Task worker Compatibility	Inappropriate task worker matching may affect the quality of deliverables.
12		Intrinsic Motivational Factor	That may include duration of task completion, skillfulness, cost paid and the complexity of task assigned.
13		Extrinsic motivation	That's includes Immediate vs. delayed pay off, high ranking motivation is requester with brand name e.g Google, yahoo

14		Quitting rate	The rate at which workers choose to register for task and then quit it without submitting his work
15		Task Duration	How much long task will take to complete
16	ID_06	Dedicated developers	These software developers have to obtain the project-specific knowledge about the system Being developed by the developers.
17	ID_07	Task Documentation	Because of uncommunicated or misinterpreted requirements of software can lead crowd workers to deliver a solution that does not meet the customers 'product requirements. Participation in contest is decreased if participants were unclear od undecided about what problem they want to solve.
18	ID_08	Higher Task reward	Would result higher quality submissions from crowd by appealing reliable delicate participants.
19		Communication	Communication between participants and crowdsourcing platform.

20	ID_09	Participant with domain knowledge	It is effective to cluster the participant having knowledge of same domain in same spatial and temporal grounds.
21		Level of coordination and communication	A good level of coordination ensures better result between crowd composition project makers as well as with stakeholder on geographical grounds by at least improving language barriers. All the information needs to be as clear as possible.
22		Data security problem	As it's an open call format, the general public can assist.
23		Intellectual honorship or patent	These issues may arise as all the information are public task may be reproduced by other rivals.
24		Crowdsourced software quality	It includes four aspects prosperity level of platform, scale of task, expertise of participant and the design quality.
25	ID_10	Complexity of task	Owing to expertise of crowd it needs a lot of investment from managerial side to match testing task with expertise of tester.
26		Clarity of task	The clear goal of task assigned to crowd have strong impact on all the procedure and performance of crowd.
27		Monitoring crowd during work	It is worthy to formulate the mechanism that could monitor

			crowd during work cycle it will help in low defect detection rate.
28	ID_11	Collaboration	Collaboration among crowd should be automated as much as possible, to help and guide developers to form sub-communities
29	ID_12	Task Reward	Task reward is one of the core influential factor for the crowd to participate in the crowdsourcing contest.
30		Requesters with brand name	Another high ranking motivation factor which attracts software workers to participate in CS
31		Elaboration of tasks	It is extremely important to elaborate the task completely because it is directly affect the task reward.
32	ID_13	Money	Money reward is motivational factor for participating In crowdsourcing contests.
33	ID_14	Task Price	Task Price is most important incentive to attract crowd participation.
34	ID_15	Task Documentation	Documentation associated with the successfully completion of the task is important for its effective implementation.
35		Task Management	Main difficulties met by the crowd participants relate to finding a task According to their

			profile and understanding of task.
36		Platform Usability	When user use the platform, would not found any difficulty in finding the material available to perform task.
37	ID_16	Worker Reliability	Reliability of worker is longstanding issue in virtual communities, because a one of the major challenge in crowdsourcing is detecting useless workers.
38	ID_17	Keeping Participants Motivation	Keep motivate the participants of contest during the task solving process to get better result.
39		Micro task decomposition	Decomposition of task into different micro sub task for the better understating of crowd.
40		Task allocation	Allocation of task to relevant crowd who is familiar with the task requirement.
41		Task documentation	Misinterpreted ur incomplete documentation of requirements of tasks my lead to wrong solution.
42	ID_18	Poor Task Management	Participants of contest had trouble finding a task which is suitable to their skills. And also in trouble in understanding how much time and effort it would take to finish the task.

43		Language barrier	One of the crowdsourcing platform TopCoder is just in English and doesn't support automatic translation tool to other languages.
44	ID_19	Monetary prize	Prize Money for wining participants is one of the top motivating factors to attract and involve suitable crowd in task solving.
45	ID_20	Task Decomposition	Decomposition of complex task into different sub tasks to get solution of task
46	ID_21	Collaboration	Collaboration among solver and seekers both.
47	ID_22	Monetary Reward	High monetary reward attract participant to invest more effort in contest
48	ID_24	Favorite games promotion	Participants can choose to participate in crowdsourcing contests that promote their desired games to make them more attractive For themselves.
49	ID_25	Task Development Efficiency	The Shorter the real development time required by the participants during the development cycle given higher task efficiency.
50	ID_26	Task Complexity	Complex task need more specific expertise to complete task.
51	ID_27	Financial feasibility	Ensuring budget limits are not violated.

52	ID_28	Link Count	Task that has an embedded link in their description that provide additional information are more likely to win contest.
53	ID_29	Task Scheduling	CS task are typically scheduled into prototyping, decomposition, bug hunting and fixing, assembling of task and then coding.
54		Resource allocation	A better resource allocated task lead to faster project completion rate.
55	ID_30	Asynchronic behavior of task	To deal with this behavior within threat of upcoming deadlines for task completion.
56	ID_31	Vulnerability of platform	CS is used centralized platform which is vulnerable to malicious attack and also has risk of privacy disclosure or even data loss.
57	ID_33	Software innovation	CS facilitates community based on innovative software development by coordinating challenge in projects
58	ID_35	Quality match productivity	A combination of task and virtually acceptor team build up quality and productivity.
59	ID_36	Fund Leveraging	At certain stages CS project stimulate other companies to sponsor some project, thus it result in more money to be added in this specific area.

60		Marketing	CS raised the publicity of organization among potential participants help in people recognizing name and nature of business by companies
61	ID_37	Task Similarity	Task Similarity have positive impact on participation time by the participants of competition.
62	ID_38	Monetary reward	Monetary reward motivate honest users to participate in competition
63	ID_39	Task Clarity	Clarity in task lead to best and successful solutions in crowdsourcing
64		Task Complexity	Complex task need more participation time to get better result.