

# An Overview of Crowdsourcing Concepts in Software Engineering

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*Abstract:* The effect of crowdsourcing has increased dramatically in recent years. This paper focuses on the crowdsourcing concept and research in software engineering from different aspect. First, the definition of crowdsourcing is given in detail, together with its challenges in software engineering. Furthermore, different development approaches such as insourcing, outsourcing, open source and nearshore are represented with their differences from crowdsourcing. Currently popular commercial applications, platforms, business models are given. The idea behind its pricing theory is discussed.

*Key-Words:* Crowdsourcing, software engineering, software development.

## 1 Introduction

Crowdsourcing has started to gain much more attention in software engineering research areas, from coding to development by means of special platforms and applications. Beside, crowdsourcing has been applied to various domains, such as labelling large datasets [1], creative and design-based applications [2], and translation of text to different languages [3]. Crowdsourcing utilizes open call format in order to offer tasks of different companies to a large group of people/committee. The community decides whether it performs tasks by attending competitions or not. The crowdsourcing term is first defined by Jeff Howe in a Wired magazine article as: “Crowdsourcing utilizes from networked world and labor is not always free, on the other hand it costs a lot less than paying traditional employees [4]. There are several issues in crowdsourcing process in terms of requestor, crowd and platform in software development [5]. Crowdsourcing requestor specifies and submits task descriptions and performs management operations during crowdsourced progress. Beside this, the crowd achieves goals of the released tasks individually or collaboratively in specific time allowance. The final role in crowdsourcing process is the crowdsourced platform. The crowd submits their works through the crowdsourcing platform. In other word, when the task is done by the crowd, crowdsourced platform intermediates between the crowd and the requestor who evaluates the quality of the work. According to the quality level of the work, crowdsourcing requestor makes payment to the collaboratively

worked members or to the best solution.

In related literature, several crowdsourcing approaches have been encountered where crowdfunding is one of them. Crowdfunding is defined to be a development approach where financial resources of projects are funded by large number of individuals in terms of entrepreneurs, nonprofit organizations and artists in order to develop the projects on the internet [6]. The effect of crowdfunding has increased dramatically on design, film making, music and photography projects [6]. Crowdfunding approach relies on crowdsourcing, but there is a big difference between them. In crowdfunding, financial resources of projects are collected from the crowd, whereas in crowdsourcing, the crowd works collaboratively in order to achieve common goals of the projects. Kickstarter and Indiegogo are two of the popular examples of crowdfunding platforms. Crowdfunding has four business models [7]. Equity-based crowdfunding points out that supporters will gain shares by means of investing in certain projects. Lending-based crowdfunding states that individuals support projects in order to gain interest rate. Reward-based crowdfunding emphasizes that entrepreneurs provide monetary rewards to supporters. In donation-based crowdfunding, individuals support creators without any kind of tangible rewards. Figure 1 illustrates variations of crowdfunding [7].

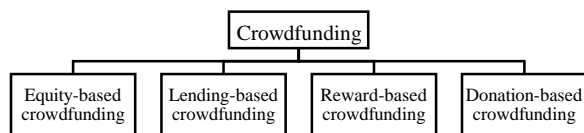


Fig. 1 Variations of crowdfunding [7]

In another research, crowdfunding is classified into four groups in terms of relationship between the crowd and entrepreneurs [8]. The first crowdfunding model is the *donation-based crowdfunding*. In this model, entrepreneurs expect funds in order to develop their prototypes or mass production. Moreover, donation-based crowdfunding platforms is divided into two groups [8] *Fixed funding*, where entrepreneurs expect the fully fund of the requested amount for their projects within in a certain time and, *flexible funding* where there is no fully fund for the projects. Another crowdfunding model is *crowdfunding investing* (CFI), which individuals support significant capital for creators to develop their projects. CFI has also three approaches: *Equity crowdfunding*, where supporters provide funds for creators in return for equity in the business, and *debt crowdfunding*, where individuals support creators via debt. Another approach of CFI is *royalty-based crowdfunding* where the crowd provides proportion of revenue. *Internal crowdfunding* is another model of crowdfunding. It provides opportunity for employees to spend funds which is given by companies for the useful projects within their companies. The last model is the *hybrid crowdfunding*, which supports more than one approaches by means of supporting both requested fund as a credit and grant for the production of the product or service at hand [8]. Figure 2 summarizes crowdfunding approaches represented in [8].

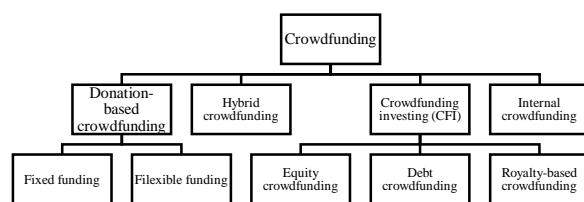


Fig. 2 Crowdfunding approaches [8]

The crowdsourced design is an approach of crowdsourcing. The goal of crowdsourced design is designing something by funding a large group of people. 99designs, which performs designs such as logos, web design, etc. is a popular commercial example of crowdsourced design approach.

Another variation is *crowdwisdom*. The main

idea of crowdwisdom is that people ask their questions to the large group of people who are willing to answer. The main concern of crowdwisdom is the independencies of individual opinions. Yahoo Answers is one of the popular application area of crowdwisdom on the internet. Figure 3 illustrates crowdsourcing aspects.

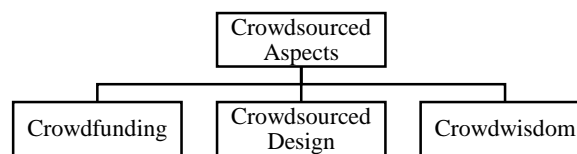


Fig. 3 Crowdsourcing aspects [9]

The remaining parts of this paper are organized as follows. Section 2 emphasizes insource, outsource, open source and nearshore software development approaches. Section 3 points out different crowdsourcing applications and platforms. Section 4 describes business models of crowdsourcing. Section 5, pricing models of crowdsourcing are elaborated. In Section 6, we present discussion and future works.

### 1.1 Motivations and Challenges of Crowdsourcing

Crowdsourcing is seen as a good alternative for academia and industry as a means of software development approach. Crowdsourcing is believed to enhance efficiency of the projects and reduce their development times and costs. Besides, it is possible to find a large number of people/community who are willing to work for crowdsourced projects at any time. That is to say, crowdsourcing provides flexible workforce. Flexible workforce is a chance for using specialist freelancers. Moreover, the work which is divided into smaller tasks requires minimum coordination demands; hence is a chance for decreasing the developers' individual effort in order to accomplish the whole project. This results in the increase in development speed. Development speed is one of the motivation behind crowdsourcing.

In crowdsourcing, multiple developers independently work to produce solutions; thus, it is possible to produce higher quality solutions by developers [10]. Difficult tasks for computers are achieved successfully by means of human intelligence. From the developers' perspective, crowdsourcing provides opportunity in order to improve themselves and learn new technologies by means of attending to actual projects.

On the other hand, there are some drawbacks in crowdsourcing approach. Collaboration between a

large group of workers leads to management problems. This problem causes waste of time due to the fact that multiple workers create similar designs for the same works. Besides, some complex software projects require dependencies between tasks. Therefore, every software project is not suitable for crowdsourcing in terms of workflows security, privacy and law enforcement [11].

Crowdsourcing has been used by various research areas, where bioinformatics constitutes one of them. This approach solves several bioinformatics problems by means of accessible straightforward crowdsourcing platforms such as Amazon's Mechanical Turk [12] which is an opportunity for bioinformatics researchers to complete tasks in a short time frame and lead to diversity in solutions of problems. On the one hand, complex and knowledge-rich tasks and organizing efforts of the scientific community are strengths of the crowdsourcing approach in bioinformatics [13]. In addition, poorly performing workers and proposing the right problem to the crowd are other challenges of crowdsourcing in bioinformatics research area [12].

Mobile phones and related applications are another application area of crowdsourcing. The sensors, network connectivity and cellular radios on the smartphones may be used with the computational power of crowdsourcing activity. This plays significant role on several human intelligence and human sensor application development, such as human perception, understanding, intelligence, visual recognition and so on with powerful mobile devices [14]. However, using mobile devices for crowdsourcing also leads to some drawbacks in terms of energy and bandwidth limitations, quality of outcome, task design, reward mechanism, privacy and security threats, high quality contributions and design of appropriate platforms.

Crowdsourcing in mobile network emerges new opportunities. The reduced organizational overhead, multiple simultaneous measurement from different locations, cost reduction, evaluation of performance metrics from the end user perspective are several benefits of crowdsourcing in mobile network issues [15]. Nevertheless, security, privacy, volunteer contribution, battery consumption of mobile phones, data quality, optimization of the number of samples due to redundant information, task design, data volume consumption, accuracy are the main concerns in mobile network applications.

Natural Language Processing (NLP) is another application area of crowdsourcing [16]. Cost reductions in language resource, extended NLP

resources, time-efficiency, self-improvement, less overhead, diversity because of wider participation are the main attractions of crowdsourcing in NLP. However, assembling inputs of the crowd, defining the evaluation task with high quality to compare algorithms of NLP tasks, additional interface design costs, licensing, legal and ethical problems and privacy are among the concerns of crowdsourcing in NLP [16].

Education is a further application area of crowdsourcing via higher quality evaluation on student progress, rapid question answering, gathering ideas from the crowd, improvement on communication between lecturers and students, providing funds for students, crowdsourced class materials, sharing knowledge, creating platform to judge different opinions of students and increased motivation [17]. On the other hand, quality control on course content, long-term engagement, producing quality feedback for coursework, reward systems for students are related challenges.

The number of countries which are interested in and currently using crowdsourcing is growing. For instance, there are several crowdsourcing platforms (Zhubajie, Epweike and Taskcn) in China. Furthermore, some companies create crowdsourced campaigns in China. Pepsi's Creative Challenges which target to create brand image, print people faces on Pepsi cans and submit wishes of consumers [18]. Besides, crowdsourcing in social activities is another application area in China. DangerMap is an application which identify environmentally contaminated and polluting landfill and oil refiners using crowdsourcing approach [18]. High number of participation in crowdsourcing activities, easy accessibility and cost reduction are deduced as opportunities of crowdsourcing in China. On the other hand, there is a language barrier between client and crowdsourcing partners in China, since English is not frequently spoke among Chinese. Besides, censorship and intellectual property create business risks for crowdsourcing approach in China.

The effect of crowdsourcing in Malaysia has increased due to the possibility of being an additional income for people [19]. But, reliability of local crowdsourcing platforms, lack of experienced workers, limitation of payment systems, lack of security, not suitable task assignment to the workers and not supporting local crowdsourcing platforms are challenges of crowdsourcing approach in Malaysia.

## 2 Software Development Approaches

## 2.1 Insourcing

In insourcing, organizations achieve project goals by means of internal expertise. Instead of subcontracting to third parties, organization hire new qualified staff (if necessary), shift staffs from department to another or form a project to another or train existing staff in order to accomplish tasks [11]. Insourcing helps improving the communication among staff members. Moreover, internal IT resources are innovated via insourcing. The main challenges of, insourcing are additional costs due to hiring new staffs and software licenses.

When comparing crowdsourcing with insourcing software development, user participation, flexibility, openness, scalability and flexibility in insourcing are said to be lower than crowdsourcing, in general. However, development time, development cost, trustworthiness, license requirement, business risk and operational control of insourcing are higher than crowdsourcing [11]. If the company wants to keep control over software development process and improve its in-house IT expertise, insourcing software development is more suitable compared to outsourcing and crowdsourcing [11].

## 2.2 Outsourcing

Unavailability of sufficient in-house expertise results in outsourcing software development for organizations. In other words, organizations contract with external providers in order to achieve temporal tasks, focus on the core functions of the business or reduce cost. Difficulty of finding the right service provider according to its expertise is the main drawback of software development via outsourcing [11].

Crowdsourcing and outsourcing usually are regarded as closed terms. While crowdsourcing utilizes open calls to achieve tasks from volunteer workers (mostly not professionals), outsourcing achieves tasks via contracts with other employment relationship of companies or professional organizations. Besides, outsourcing performs tasks via business relationships [20], while crowdsourcing depends on participation motivation. In addition, development time and cost, confidentiality, software license issues, business risks and management control of outsourcing are said to be higher than crowdsourcing [11]. On the other hand, transparency, ability to have tailored product, user participation, scalability of crowdsourcing are higher than outsourcing.

## 2.3 Open Sourcing

In this approach, a large group of developers evolve software projects collaboratively by means of redistributable software without any financial reward. Speed, quality and cost of development are main concerns of open source software development methodology [21].

There are some differences between open source software development and crowdsourcing approach. Projects which are achieved by crowdsourcing approach are not distributed in public, while open source software development contains freely distributed software. Besides, developers contribute to the projects via open source software model while crowdsourcing achieves not only software development but also several software tasks. People work independently or collaboratively in order to perform crowdsourcing tasks while people work collaboratively in open source software development [20]. User participation, openness, scalability and flexibility are said to be higher in open source software development compared to crowdsourcing. However, development time, development cost, confidentiality, license issues, business risks and management control are higher in crowdsourcing [11].

## 2.4 Nearshoring

Nearshore is defined by geographic proximity between client and sourcing locations [22], i.e. nearshoring is associated with outside of client country but proximate to sourcing countries. By using the proximity of geographic, cultural, linguistic and economical characteristics between countries, client countries achieve their tasks at lower wages in sourcing countries [22]. There are three major nearshore clusters in the world: the USA and Canada, wealthy nations of Western Europe and Korea and Japan [23].

## 2.5 Offshoring

In offshoring, the project is performed between clients and supplier organizations which are located at different countries. The main motivation behind offshoring is cost reduction. Communication limitation, language barriers, cultural differences and political issues are among the drawbacks of offshore software development [24].

## 2.6 Crowdsourcing

Crowdsourcing has become an emerging area for both academics and industrial world. It is applicable to software development process when open calls

are utilized in order to have the tasks done by a large group of volunteer people. Crowdsourcing has three main models: peer production, competitions and microtasking [10]. In peer production aspect, open sourcing is the oldest model where people evolve works collaboratively without any reward expectation. Competitions constitutes the other approach of crowdsourcing where workers compete with each other for achieve projects' goals in order to gain monetary rewards. The client identifies project requirements in terms of its description, budget and time. The requirements are submitted to the crowdsourced platforms. The copilot/platform manager divides the projects into several tasks which are competition tasks with different rewards. The large group of workers i.e. community propose diverse solutions for these tasks. The best solution is voted or chosen among other solutions and winning solution is rewarded [10]. The last model of crowdsourcing is microtasking. It divides works into several self-contained and small tasks to complete in a short time period by a large group of people via scalability feature of software works.

Apart from the development approaches, crowdsourcing in software development has three main components: assigners, the crowd / providers and platforms [20]. They are the assigners who propose and initiate projects. Providers then achieve and submit their solutions for proposed crowdsourced projects. Platforms provide the link between assigners and providers. It addresses communication issues between crowd members and client enterprises to learn about information about requirements and capabilities. Besides platforms support collaboration among crowd members [25]. There are several actions between these components. Figure 4 shows these components, together with the actions among them [20].

When the project is implemented successfully via crowdsourcing, its success is determined by the evaluation of various criteria: How effective the whole process has been done? Which requirements are met within time? Are budget and quality aspects are accomplished? How about the integration by other software projects? Was the participants high talented? How was the communication and collaboration among participants and clients? Are there appropriate software license? etc. [26]. All these success metrics are put together to evaluate whether the crowdsourced project accomplishes ultimate goals.

### 3 Applications and Platforms

Crowdsourcing has been used for wide range of application and platforms, where many of them

utilize collective human intelligence. The image tagging applications of Google, Flickr, ESP Game, natural language processing application of OpenMind.org, photo sale application of iStockPhoto, coding application Rent-a-Coder and Innocentive, question and answering system of Stack Overflow/Exchange, online Filipino and English dictionary Bansa.org, online dictionary Wordnik, teaching language application Duolingo, identification of objects in the images into predefined classes application LabelMe, identification of foods in the image application PlateMate, web services for speech and music PodCastle and Songle, detection of security threats of web browsers via SmartNotes, online social health network Sickweather, improvement the quality of global land cover via The Geo-Wiki Project, Google Earth, health platform for pregnant citizens InSTEDD RemindEm, patient network PatientsLikeMe are several applications of crowdsourcing.

Crowdsourcing is an emerging approach for mobile applications. For instance, TaskRabbit helps to everyday tasks such as cleaning, delivery and moving with community sourcing, WeatherSignal crowdsources weather map, long distance ridesharing mobile crowdsourced application Blablacar, Apple's business model on mobile marketing, public transport information application TrafficInfo, urban noise sensing application EarPhone, useful mobile application for blind people VizWiz, citizen science project of crowdsourcing Zooniverse, cell phone signal measurement application OpenSignal, traffic condition application Waze, the application that gives information about places via crowdsourcing street level photos taken by users Mapillary, restrooms application Sit or Squat, network performance application The NetMap, a mobile social networking application LogicCrowd, Filipino and English dictionary Librorum, teaching languages mobile application Duolingo, mobile reporting crime applications such as Enforce Crime Map, CrimeWatch Mobile, Community Against Crime, Community Alert, MyDistress, the application that optimizes searching queries of mobile users SmartTrace+, location based social network application CrowdCast, a recommender of places such as restaurant and pharmacy mobile crowdsourcing application SmartP2P, evaluation of mobile crowdsourcing applications SmartLab, reporter of disaster and incidents AppLert, distributed data analytics platform for mobile crowdsensing applications CARDAP, requesting services mobile applications such as AskUs,

txteagle, video recording application placeMeter, information about numbers of cars in crowded parking areas Pick N Park, Parker, VoicePark, mobile crowdsourced nutrition information application UCap are several mobile applications using crowdsourcing.

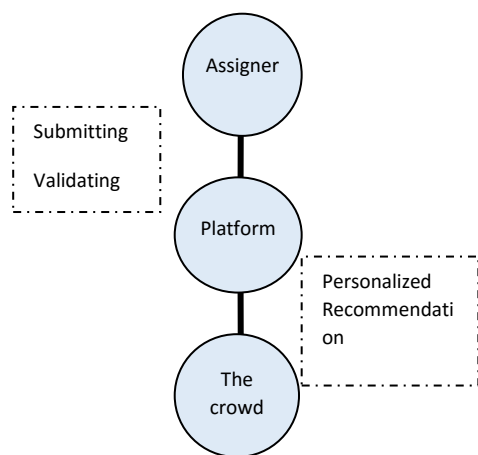


Fig. 4 Crowdsourcing components [20]

TopCoder is the most popular crowdsourced platform throughout the world. TopCoder hosts online algorithm competitions, graphic design, software design and software development issues and support participants via rewards. Besides, Amazon's Mechanical Turk or MTurk performs Human Intelligence Tasks (HIT) or micro-tasks such as identification of objects in images, labelling of images, natural language processing tasks and finding relevant information that require human intelligence by paying prices to workers. In addition, AppStori is a platform for mobile application development that is based on collaboration between crowd developers and consumers via crowdfunding model. uTest is a crowdsourced platform for software testing such as functional testing, usability testing, localization testing and load testing [2]. StackOverflow is another crowdsourced platform for asking questions and answering them. Mob4hire is a crowdsourced mobile application testing platform. Moreover, finding and hiring freelancer platforms such as Guru and oDesk, graphic design crowdsourced platform 99desings are other examples of platforms. Innocentive offers a methodology, technology, problem-solving network to crowdsource solutions to problems. Writing and editing crowdsourced platform Cloud Crowd, audio

testing platform crowdMOS, quality assessment tests platform QualityCrowd, playback audio clips BeagleJS, interactive mapping applications platforms such as GeoChat and Ushahidi, ubiquitous mobile sensing applications platform mCrowd are also examples of crowdsourcing platforms. Also, Quadrant of Euphoria performs quality of experience of network and multimedia experiment, platform for crowdsourced design tasks Microworkers, text creation tasks of Clickworker, ZhongYan for image annotation, video recognition, analyzing number of bees visiting the sunflowers and pollination Great SunFlower, for collection information about birds eBird, crowdsourcing platform for human or machine computations Crowd4U, for identification of natural language texts ZenCrowd, for developing requirements for projects submitting by individuals or corporations CrowdREquire, for electrophysiology CrowdLabel, platforms for collection locations form citizens such as InfoAmazonia, platform for bike share feasibility Shareabout, reporting street problems FixMyStreet, an online community platforms for developers such as CoFundos, Genius Rocket, competition-based design and innovation platforms such as Muji, Threadless, PeoplePerHour, marketing and sales competition based platforms Marketocracy, PeerToPatent, Spot.us, Predictify, localization information provider gMission, Askville by Amazon are other crowdsourced supporting platforms [5]. Furthermore, software tasking domain has several crowdsourced platforms such as Passbrains, Testbirds, Testbats, Pay4bugs, CrowdTesters [2].

## 4 Business Model

This section focuses on business models for organizations and participants of crowdsourcing. However, although crowdsourcing has been popular with numerous applications and platforms, it has not yet gained enough attention about business models. It is obvious that future works will consider different types of business models.

A well-known crowdsourcing business model is conducted by Apple. Apple's AppStore is an online crowd-funded application market in which developers who are motivated by both reputation and payment mechanisms submit their creative designs and products to smartphone customers. There are numerous other collaborative platforms for the smartphone applications. AppStori is a collaborative crowdfunding approach for development promising ideas about new iPhone applications, and it provides preview window to support the promising projects for iPhone

applications [28]. The founders of the project team initiates process by posting a project proposal. AppStori review board maximizes the weakness in the proposal in order to ensure quality of the accepted AppStori projects which is conducted by crowd. The project team try to push the project toward the milestones in the proposal and minimize the probability that the donation crowd would withdraw their contributions [28]. Moreover, beta testers are collaborative with project team to minimize the bugs in the code before successful projects submit AppStore review board of Apple [28].

Apple's business model is based on interconnection of hardware and software components [29]. Apple outsources hardware development to developing countries such as Taiwan and China with low-cost manufacturing model while software is developed by highly skilled technical workforce such as Western economies in order to situate within hardware [29]. Not only, crowdsourcing can help Apple by manufacturing high-tech labor without negating spatial restrictions, logistic problems of applications and employment costs, but also Apple avoids employment costs of contracts and investment in-house product development but volunteer workforce provides benefit for capital. That is to say, when members register the App Store platform to create applications, Apple utilizes crowdsourcing approach for its software development.

However, there are some differences between crowdsourcing approach and Apple's case [29]. While crowdsourcing is performed by open call format, the call is achieved by registration in the platform in Apple's case. Besides, crowdsourcing requires contractual obligations for productivity, but Apple ensures productivity via particular rules engagement. Also, there is no direct monetization in Apple, but development cost is met by developers. In addition, there are neither explicit ranking of individual designers and not contest prize for each project in AppStori platform [28]. Instead of ranking and contest prize mechanisms, AppStori team defines success of projects in terms of deadlines, budget and crowdfunding support which are determined by project teams and the involved evaluators [28]. Fundamentally, crowdsourcing addresses centralized control over development and distribution of application issues of Apple's business model.

According to these business models, crowdsourcing software development markets known as CSMs are becoming more popular than traditional software outsourcing markets [30].

Providers as agents in CSMs contract in order to develop software or projects by fixed price outsourced activities which the price of project is determined before work begins and when milestones are reached, the price of the project is paid instead of traditional outsourcing contracting. According to this aspect, the effect of CMSs has increased in software development crowdsourcing.

## 5 Pricing Model

Pricing models of software crowdsourcing can be broadly classified into two categories: Auction-based crowdsourcing, and game theory-based crowdsourcing.

Determining the right incentive mechanisms for crowdsourcing have been extensively studied under the framework of auction based models. All-pay auction is a type of auction in which everyone pays for their bids in the form of individual effort regardless of who wins the auction, and the highest bidder wins the auction. When this auction model is considered for crowdsourcing contests, all developers submit their solutions, but only the best solution is rewarded. Performance of multiple skilled workers and rating information provided by requesters generates user profiles takes into account in order to match tasks to suitable workers in auction aspect [31]. [32] has analyzed the relationship between participation and incentives in all-pay auctions with incomplete information, where a given player does not know the skills of the other players. All-pay auction under incomplete information can be divided into two classes: sequential all-pay auction, and simultaneous all-pay auction. Solutions are submitted sequentially, and the best solution is selected as the winner in sequential all-pay auctions under incomplete information, while users do not see others' solutions before submitting their own in simultaneous all-pay auctions under incomplete information [33]. There has been study about these issues in terms of effects of reward and reserve quality on both participation levels and submission quality [33]. On the collaboration strategy on auction, there are two scenarios in terms of mergers and collusions. Mergers achieves collaborating players who works together to prepare a single submission, whereas collusion defines that cooperating players keep their collaboration secret. In addition, higher price leads to more participation and higher answer quality [34]. Furthermore, auction utility model can be the sum-profit type in which the auctioneer obtains bids from all participants, or the max-profit type in which the auctioneer only uses the best submission [35]. The effects of these collaboration strategies i.e. mergers

and collusion under two scenarios in all-pay auctions are studied in [35].

Designing optimal pricing policies by game theory-based models is another way. TopCoder is one of the most popular crowdsourcing platforms, therefore numerous works in literature have used TopCoder as their application platform. A game theory-based model for algorithm challenge of TopCoder has been studied in terms of competitive behaviors through Nash equilibria [28]. Another conducted research on algorithm challenge on TopCoder about competitive behaviors has been studied via a multiple-person game model [36]. According to this study, if the contestant's probability of making a successful challenge exceeds the threshold value related to the cost of launching such a challenge, he will always decide to challenge [36]. That is to say, higher rating contestants are prone to challenge than lower rating ones. Nonetheless, higher rating contestants can be unwilling to challenge due to fear of losing their high points in the contests [36]. Stackelberg game model is another game theory-based model that is used for pricing of software crowdsourcing. Stackelberg game is based on leader-follower structure known as requester and worked in crowdsourcing in order to maximize utilities of both sides by optimal pricing and allocation [37]. In order to maximize the utilities of crowdsourcing workload assignment and pricing mechanism, two-stage optimal win-win strategy by Stackelberg game model can be designed for the optimal strategy [37].

## 6 Conclusion

This paper introduces that quality of software in terms of security, performance, reducing deadline of the projects, cost reduction, proposal of diversity solution by talented workers, self-improvement via new technologies and increasing possibility of finding funds with high level of participations are among the goals of crowdsourcing approach in software development. On the other hand, crowdsourcing in software development contains some challenges. Decomposition of projects into work break down structure, coordination and communication problems, management, scheduling project development, quality of proposed solutions, security, law enforcement, large number participations are among the main concerns of crowdsourcing software development. The paper summarizes the concepts, business models and currently popular platforms of crowdsourcing.

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