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THE ROLE OF MOTIVATIONAL THEORIES IN THE SUCCESS OF CROWDSOURCING ENGAGEMENT MODELS: A REVIEW

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ABSTRACT

A plethora of research has been conducted on motivational theories in various fields including medical sciences, business and management, physiology, and sociology, especially in the natural sciences field. Motivational theories are considered a key to motivating the crowd over the internet to participate in the assigned tasks over online platforms commonly known as online crowdsourcing. However, research regarding the review of the theories discussed is scarce. Therefore, this literature review focuses to identify the motivational theories in literature over the last decade and mapping these theories onto the engagement models of crowdsourcing. Based on a review of 91 papers from the natural science domain, we identified 36 motivational theories and mapped the identified theories over crowdsourcing models of engagement. The analysis of the study identified the popular theories among the researchers as well as the new and nascent theories practiced in Crowdsourcing, from 2010 to 2021. Similarly, the mapping helped to identify the nature of the contribution and the theories' importance. The literature review help to understand the recent trends to motivate participants using motivational theories and help identify trends and possibilities for future research.

Keywords: *Motivation; Theories; Crowdsourcing; Engagement; Models; Literature Review.*

1. INTRODUCTION

Motivation is a crucial aspect that helps people to engage in a variety of tasks, to accomplish goals [1]. Motivation is a multidisciplinary research topic and has been discussed in various fields, such as business and management [2], medical [3], social sciences [4], psychology [5], and many more. Motivation is considered as the drive that engages individuals in an act that is either objective (a goal related) or subjective (that exists in the mind) [6]. Such motivation helps individuals to experience desires and aversion [7]. If individuals are motivated positively, it produces enjoyment, entertainment, and fun to act on that impulse.

Various motivational theories have been formulated by many researchers, to set ground realities of motivation by studying human physiology, like the Self-Determination theory (SDT) coined by Edward Deci and Richard Ryan [8], a Game theory coined by John von Neumann [9], and Jacquelynne Eccles who coined Expectance Value Theory (EVT) [10]. Such theories over time are identified as promising theories of motivation and have proven their worth and effectiveness. The success of such motivational theories has recently gained popularity among researchers in the field of natural sciences.

Researchers working in different fields have shown great concern over motivational theories since their emergence and success. Such theories have proven to be effective when applied in practices like in industries, where the management implements motivation for workers to stay positive and perform tasks effectively and efficiently, in research, where researchers need feedback from a larger group of individuals, and in society to get the sense of community and experience as an active member.

The emerging era of IT has proved a need to develop new platforms for mass-engage where the integration of IT and online methodologies will prove to be effective and efficient [11]. One such emerging platform of study is called crowdsourcing (CS). The term “crowdsourcing” was first coined by Jeff Howe in 2006 [12]. CS can be defined as, how someone can leverage the power of others (masses) to attain feats, which was once the specialty of very few. CS has significantly helped researchers and other industries based on an individual’s demography, to push tasks and receive

feedback using online platforms [13]. The participants who engage with platforms to perform tasks are called crowds or solvers.

CS can be done in a variety of different ways, earlier, offline work was preferred but for divergence, researchers recommend online platforms; platforms with diverse participants, experiences, and expertise. Depending on the circumstances and application, motivation has many different interpretations, similarly, its integration into CS has proven to be quite effective [14]. This paper uses the Brabham definition of crowdsourcing as "an online, distributed problem solving and production model that leverages the collective intelligence of online communities to serve specific organizational goals" [15].

The effect of motivational theories is considered a determinant of an engaging crowd over CS platforms. Researchers have adopted a variety of such motivational theories, with motivational features that are either internal, external, or both, on online platforms, to keep the participants engaged toward a task. Platforms incorporate theories, such as Gamification [16]–[18], Game theory [19]–[21], Self-Determination Theory (SDT) [22]–[24], and Expectancy-value Theory (EVT) [24]–[26] to evaluate the engagement of participants. Theories are coined based on the set of motivational features that enforce when implemented, for example, SDT has wide application, as it motivates individuals by providing the three basic needs to keep individuals motivated, namely competence, autonomy, and relatedness [8]. Similarly, the Game theory has gained popularity as it motivates individuals by using game elements like levels, badges, rewards, and game elements. Furthermore, Gamification motivates by using game mechanics [27] on the platforms and other theories implement other features on need basis factors like reciprocity, entertainment, enjoyment, altruism, and psychological empowerment, which includes self-efficacy, sense of community and casual importance, while others preferred the external features like rewards, experience, awards, etc.

With the dynamic complex environment of CS, the motivation of the crowd is a challenge, and critical to integrate the platforms with theories and their internal or external motivational factors, which will be effective towards the completion of a specific task. Different platforms are available worldwide namely Mechanical Turk [28], TaskCN [29], Facebook [30], eWiki [31], and others, where there are millions of solvers available, with enough experience and expertise which researchers find useful to achieve the required tasks. To engage the solvers in performing tasks researchers have come across wide problems, like solvers losing interest, quitting, or becoming redundant. Few studies have forced on addressing such challenges by integrating features of two different theories of motivation, which promised positive engagement and results [32]. However, researchers have parsed the CS ideology into other aspects like Crowd-funding [21], Crowd-solving [33], and Crowd voting [34], merely gaining experience from previous research, which they believed, that such aspects, bring more competition and therefore better engagements rules.

Researchers have gained much insight from previous research experiences and they understand the importance of the motivational aspect of the engagement. It has become more evident that new theories with more promising engagement rules must be introduced, validated, and implemented. Similarly, legacy theories must be fine-tuned accordingly, for a high success rate [35].

A study on CS has proved that the platforms built for CS engagement have developed certain models [36], [37], and crowd engagement on such platforms can be categorized using these models. The models identified engagement as peer production, competition, and task granularity. The engagement of the crowd can be categorized by combining these models, like peer production in combination with task granularity or simply engagement can be purely for an understanding of task granularity or competition. A peer production model of crowdsourcing can be sub-classified as where the crowd is given no reward and individuals join the campaign merely for experience, sharing, or contribution. The competition model engages the crowd by requesting work and the workers get paid against the contests, bug finding, or similar contributions that may improve the design, implementation, architecture, or similar contributions to produce high-quality results. Similarly, task granularity is focused on the task and testing of crowd-based on the complexity or levels of the task.

This literature review identifies the theories of motivation that have been practiced from 2010 to 2021. We begin with detailed research of motivational theories, their success, and implementation, specific to CS. We draw from the identified theories on the importance of motivation,

and how successful these theories were when implemented online and on ubiquitous platforms. We identified new and nascent theories and discussed their impact on motivational research for the researcher who faces challenges while motivating the crowd. Additionally, the mapping will guide researchers to identify the models of engagement over which these theories lay their grounds of motivation. Additionally, we mapped the extracted theories over crowdsourcing engagement models and categorized them accordingly.

This article is structured in the following way: Section 2 gives a short overview of the different types of motivational theories. Furthermore, it gives an overview of related work on the theories of motivations practiced and the models of contribution over CS platforms. In Section 3, we define the methodology of our research design which includes research questions, research criteria, and quality assessment of our study Section 4 briefs the background Analysis of the results of the systematic literature review (SLR) and Section 5 discusses the research questions of the study which helped us to evaluate the theories of motivation which were successfully implemented and practiced and developed the context that helped to successfully map the theories over the models of contribution for CS platforms. In Section 6, we discuss the outcomes of our study and section 7 concludes the study.

2. BACKGROUND OF THE RESEARCH

Motivation is a philosophical concept that helps to explain the induction, purpose, severity, constancy, and quality of behavior [38]. Motivation is considered multidimensional and it is described based on its multitude and orientation which are related to the individual and his experience [39]. The word motivation comes from the Latin dictionary meaning to “stimulate”. Motivation has been awashed by many researchers in various fields of studies, where these definitions of motivation have evolved their meaning and application. Motivation generally is defined as, “a process that starts with a requirement or a physiological or psychological deficiency and the cause of activation of behavior either to a target or encourager [40]”, or “a reason of stimulating, orientation and maintaining human behavior towards achieving a goal”.

The theories of motivation as they evolved, were also categorized into groups. These groupings are based on various aspects. For instance, energizing and/or directional where energizing defines maintaining and arousal aspects of motivation [41]. Some definitions have also tried to account for the ones engaged in an activity as opposed to another, or for the variability of behavior in general [42] While other definitions in such categories emphasize aspects such as goal-oriented behavior, attraction by incentives, and adaptive consequences [43].

Authors have expressed the importance of motivation in many domains of education research, motivation is considered a key determinant of learning. It is also used to explain the attention and effort of the students dedicated to particular learning activities [44]–[46], it is the driving force of students' choices and the extent of their engagement, effort, and persistence in their learning process [27], [47]. In industry, it is considered to affect performance by influencing the way that individuals allocate effort to tasks [48]. In society, social motivation allows them to meet and form relationships with other people, and help, chat, work, and collaborate with other players [11], [49].

The earliest theories of motivation that were recorded, after the Renaissance, which redefined the motivation is “Two-Factor Theory”, presented by F. Herzberg in 1959, where the author discussed the satisfaction and no satisfaction of a job based on factors. René Descartes's work on motivation was recognized in the 1960s that distinguished between inactive and active aspects of motivation. Descartes stated that "body" is an inactive motivating factor while "will" is an active motivating factor. Similarly, McGregor’s Theory X and Theory Y of motivation which was presented in the 1960s identify polar differences in subordinates at work [50].

As the concept of motivation is quite old, the most recognized theories that are identified and documented in the presented psychology of motivation are the Self-Determination Theory (SDT) [38], [51]–[55], Expectance-Value theory (EVT) [10], [56]–[58], and Social cognitive theory [47], [59], [60]. These theories have proven their worth and have gained a lot of popularity over the past decades. Researchers have also identified new theories that are under consideration by many researchers. They have integrated to verify such theories in research that some of the outlined theories are Game theory [51], [61], Gamification [56], [62], [63], Long-tail theory [64], and Item response theory [65], [66].

Researchers have understood the importance of motivation, where human engagement is considered. Theories of human behaviors, when applied considering the features of motivation, enlighten human psychological characteristics which are driven by the motivational features. These features may be considered instrumental [67], [68] and experiential [69]. Instrumental features are learning, pragmatic, increase in pay, rewards, etc., and experimental features are hedonic, pleasure, joy, etc. It is these features that are considered by many researchers as fruitful for attaining the results, some call them features and others name them as factors of motivation. These features which are presented by the theories are being considered by many authors, either as a whole or partially on platforms that are available to population for engagement, and these platforms are managed offline, online, or both.

With the high usage of the Internet and ubiquitous platforms drawing popularity, it is evident that researchers, who are interested to achieve the research goals, are also looking for new platforms with diverse demographic presence. Such platforms with resources available with vast knowledge and experience may be helpful leading to an understanding of the problems at large, on a wider range, rather than local ideology. To outreach people worldwide, researchers are looking into platforms that may be accessed using online ubiquitous technology. CS as a nascent model itself has gained much traction online and is becoming popular among the crowd and seekers for engagement for the ubiquitous engagement which is on the horizon [70].

CS is a problem-solving model that takes the leverage of tapping into the power of the crowd [71]. Recruitments are merely based on experience, knowledge, and exposure to the problems solved on CS platforms. Traditionally, it is defined as "an online call for a group of people to complete a task, using their resources" [72]. Others have defined CS differently Howe [12] explains CS as "the practice of obtaining needed services, ideas, or content by soliciting contributions from a large group of people, and especially from an online community, rather than from traditional employees or suppliers", Erickson [73] defines CS as "Tapping the perceptual, cognitive or enactive abilities of many people to achieve a well-defined result such as solving a problem, classifying a data set, or producing a decision". Similarly, J. Noble [74] explains it as "a method of distributing problem-solving, allowing members of a community to collaborate across a global playing field to devise solutions".

A variety of CS platforms are available worldwide. The popularity of platforms is based on the number of crowds or solvers available on the platforms. Early platforms employed crowd voluntarily [75], [76] but as the CS platforms have become popular with the increase in the number of subscribers typically ranging from hundred thousand to millions, the campaigns of engagement changed to crowd behavior that provides compensation methods for engagement, as Yang et al explain the phenomena as an economic rule for labor exchange [31]. The CS platforms are distributed worldwide and the most recognized platforms are Amazon Mechanical Turk (Mturk) [34], [68], [77], Tomnod [76], TaskCN [57], [78], Facebook [79], Twitter [80], topcoder [81], and others.

Researchers have two motives to reach out to the crowd, the first is the creativity and capacity to solve a problem [82], and the second is to achieve the desired goals by recruiting a crowd available on the platform. This recruitment may be an open call to all participants on the platform which further leads to selection via interviewing or based on other aspects like experience, age, education, and more. Governments reach out to the crowd using CS platforms for two reasons, first for policy development using public knowledge, and second for civic engagement [83]. Crowdsourcing, when used in policymaking [84], [85], has two objectives, i.e. to complement and enhance them [84], [86]. Crowdsourcing when used for marketing results in the employment of current advertising messages and awareness of the brand [87]. Similarly, when used in industry, it is used for developing business strategies and co-creation for innovation [88].

In CS, a mix of internal and external drivers is used to motivate the crowd. Such motivational drives are categorized based on actionable and non-actionable factors. Actionable motivations are considered intrinsic and extrinsic [89]. Similarly, introjected and identified are part of the non-action features of internal and external motivation. Intrinsically motivated action is carried out for the sake of one's benefit, while extrinsically motivated activity is undertaken to obtain incentives such as direct or indirect monetary rewards or other things, to satisfy one's personal needs, or to develop one's skills or credibility [39], [90]. Whereas, introjected

is considered more of an internalized part which if not performed produces tension of guilt consciously, while identified is the type of external motivation where one identified that something needs to be done but hasn't decided how to proceed.

A study on CS has proven that its platforms use different models of engagement. Figure 1 shows models of engagement on CS platforms and they are categorized as peer production [91], competition [92], and task granularity [78]. These models are categorized based on, the type of engagement that is practiced on the platforms and the nature of the research can adopt any three or their combinations, for example, Brabham [93] engages the crowd in peer production to develop media tools for the public interest and betterment, A. Barashev [94] used competition model and engages the crowd to investigate the reward sensitivity and comes up with an efficient solution, Y. Sun [57] worked their way on the task granularity model to understand the task's moderating role. Table 1 further provides a brief description of the models and their correlation.

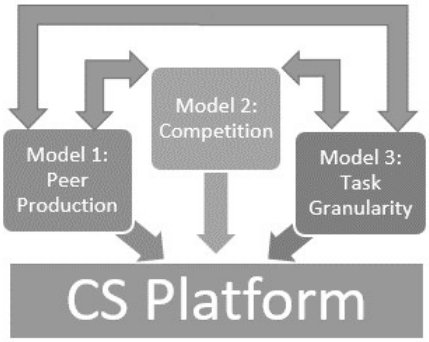

Figure 1. Crowdsourcing engagement models for crowd

Table 1. Description of Crowdsourcing engagement models for crowd

S. No.	Model	Description
1	Peer Production	No rewards, gain experience, contribute, share by answering questions, etc., for shared outcomes.
2	Competition	Get paid for work, contests, architecture, UI designing, Implementation, testing, Bug finding, to achieve high-quality results, etc.
3	Task Granularity	Task complexity, quality of work, etc.

Similarly, studies have shown that authors have engaged the crowd on platforms by combining the models, for instance, C. S.Lee and A. R. Shahid [95], [96] engages the crowd in peer production and competition models, E. D. Mekler [51] published his word-combining peer production and competition models and J. H. Pancha and Y. Sun [25], [97] engaged crowd combining the competition and task granularity, models.

3. RESEARCH DESIGN

3.1 Research Method and Research Questions

Reviewing past research has an incentive for any type of study [98], since writing literature reviews can benefit one to identify and improving what recent research work that had been done [99]. We attempted an organized, SLR of the practicing trends of theories of motivation to assess how researchers have postulated their work over a decade.

The study aims to identify the theories of motivation practiced in the area of CS. To get a clear depiction of the theories practiced in the CS environment, this study focuses on addressing the following questions:

RQ1. What are the publication trends of motivational theories in a crowdsourcing environment?

RQ2. What motivation theories are implemented in a crowdsourcing and when are their appearances in a crowdsourcing?

RQ3. How the identified motivational theories can be mapped to crowdsourcing models?

3.2 Definition of Search Criteria

3.2.1 Literature Search

To introduce high-quality literature into our search process, we searched for conferences and journals in databases like ACM, Science Direct, Scopus, and Springer, and only within the domains of the natural sciences. For example, ACM provides access to computer journals, and Science Direct provides access to many computing as well as engineering discipline publications.

3.2.2 keyword search

We searched the above-mentioned databases using "AND" and "OR" combinations of keywords from the first, second, and third categories listed in Table 2. Since we are focusing on motivational theories in crowdsourcing, we first used "motivation", "theories" and "crowdsourcing" keywords. We included combinations of "motivation" and "inspiration" as well because it relates to crowd experience on a CS platform and because authors frequently use them. Furthermore, we included 'crowdsourced' and 'crowdsourcing' to integrate the aspect of the crowd as it reflects an IT-enabled use of open innovation and because more research and practices have started to explore it over the past decade [100].

Table 2. Keywords for literature search

1st Category	2nd Category	3rd Category
• Motivation • Inspiration	• Theory • Philosophy	• Crowdsourced • Crowdsourcing

3.2.3 search process

The initial search produced results from all databases displaying 4,654 results. After applying *domain selection search* on the results i.e., within natural sciences domains, it was reduced to 673. The next filtering duplicates and reading meta-information (titles, abstracts, and keywords) of all research papers to classify their importance in understanding the basic concept of *motivation* and/or inspiration in the open creativity or co-creation sense of *CS* with philosophies and/or theories, and this reduced the number of relevant papers down to 115.

During the screening, the relevance of research articles is based on the consideration that they covered motivational and/or theories specially and/or in the open innovation of CS context. After both screening processes, the number of relevant papers was reduced to 101 We performed a backward and forward search based on the 101 papers, as suggested by Okoli [101] and Webster and Watson [98]. The quest for backward and forwards culminated in 24 more articles. We conducted a third screening process of the selected 122 papers to find those that have implemented motivational theories on CS platforms. In this third screening process, we reduced the number of relevant papers to 91 (see Figure 2); Figure 2 summarizes the paper selection and screening process.

3.2.4 selection of data source and search strategy

To identify the motivation and its integration into theories and motivational factors on CS platforms, we conducted a literature review only on the natural science domain to collect relevant literature. We used open coding to evaluate the qualitative data and to create definitions and categories from textual data. In this section, we describe in detail the qualitative data analysis and data coding process. Open coding enables the construction of definitions and categories according to properties respectively [102]. Our qualitative data-analysis process resulted in a coding scheme and enlisting of keywords that are considered properties and those findings are assigned to a category.

The two coders; an author and an external person, independently identified 91 papers from the literature search process. First, they categorized the 91 papers into papers that examined motivation and theories or both using CS, and contradictions are addressed using constructive debate. We used Krippendorff's alpha to assess the efficiency of the intercoder. Krippendorff's alpha averaged 0.82, suggesting the acceptability of the intercoder was

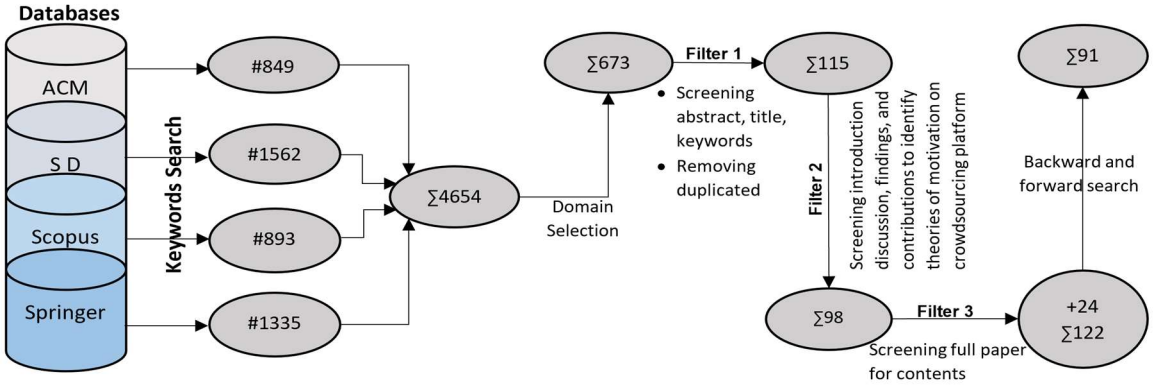

Figure 2. Paper selection and screening process

adequate. The process helped to identify implemented theories like Self-determination theory, Game theory, Gamification, Expectancy-Value theory, and 31 other theories respectively making them total of 35 theories.

Our literature-search process helped in finalizing 91 relevant papers that explored motivational theories in a CS (See Appendix A). In our qualitative data analysis process, we aimed to identify the theories implemented in the literature on CS platforms. It is found that researchers have used sub-theories which are continuums of larger sets. All the theories which are identified, are then searched, and their philosophies were read and upon identification, allocated categories accordingly, like Principal-agent theory is a sub-set of incentive theory [103], and Social Identity theory is a subset of social theory. This shows that researchers are implementing the theories, not as a whole, but validating theories by selecting sub-sets to motivate the crowd, such selection in other disciplines like management, academics, industry, etc. may help researchers understand and design a positive crowd engagement experience. In the second phase of the qualitative data analysis process, the first author and the external coder autonomously coded each paper's research onto the crowdsourcing model of contribution.

3.2.5 inclusion and exclusion criteria

Each reported study that addresses our research questions explicitly got accepted for our review and was published between 2010 till 2021 Inclusion criteria also require the study should be written in English, with a major focus on work within the domain of computer sciences and focuses on theories of motivation and application over CS platforms. The study must also be published in conference proceedings or journals with previous rigorous research.

Those studies that are opinion based and do not refer to any other study are excluded. We also excluded studies that have not implemented any motivational theories and where crowdsourcing was not a model of choice.

3.3 Study Quality Assessment Checklists

An evaluation of each included study is accessed against a standard quality checklist. Scoring is done by accessing how the theories are implemented whether the study presents clear, ambiguous, or mixed findings based on evidence and argument. Quality scores for the 91 papers are given in Table 3.

Table 3. Quality Scores of Accepted Papers

	Quality (score)			Total
	Fair (< 45%)	Good (45% - 70%)	Excellent (> 70%)	
Number of studies	21	41	29	91
Percentage of papers	~23.08%	~45.06%	~31.86%	100%

Overall, approximately above 75% of studies included in our literature review show the quality fall in good and excellent scoring criteria.

4. RESULT BACKGROUND

This section discusses the background results based on our SLR study which we considered helpful to get an overview of the nature of the study conducted.

4.1 Spacial and Temporal Analysis of Publications

It can be deemed by looking at Figure 3 that over the years 2010 to 2021, there is an increase in the published papers, where authors have considered theories of motivation in the crowdsourced.

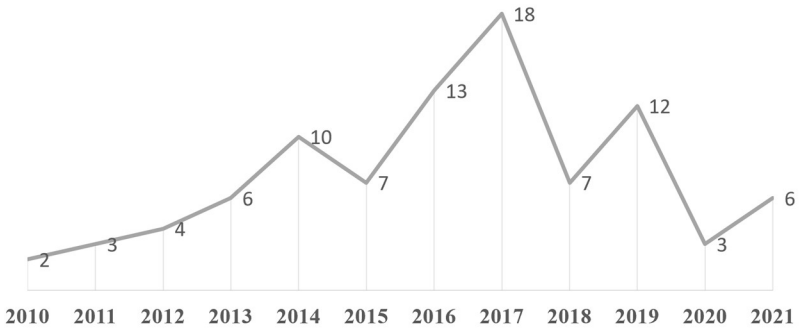

Figure 3. Number of papers selected in the literature review per year

Figure 3 helps us to anticipate that initial studies of motivational theories helped the researcher to achieve their goals which lead to an incremental use of such theories over the past six years (2016-2021) reflecting the increased understanding of the importance of motivational theories in CS. Additionally, this increase may justify the identification and validation of new motivational theories in a CS environment.

4.2 Data Sources

A study breakdown of our 91 publications from databases is presented in Figure 4. The majority of published work on motivational theories over a CS environment is found in renowned journals in the ACM Digital, like ACM Transactions on Economics and Computation, Social Computing, and Human-Computer Interactions. In Science Direct, most work is found in the Journal of Computer in Human Behavior, while Scopus journals include the International Journal of Human-Computer Studies, Journal of Computer Information Systems, and Springer Link journals include Springer Nature and Front. Comput. Sci. However, some of the work is also published as conference proceedings, while we did not find any conference published in the Science Direct database.

4.3 Geographical Spread of Selected Papers

The total no of 107 instances of countries were were identified from the 91 selected papers, giving us an aggrigriate of 24 unique countries. A large proportion of the scientific research evaluated is from the US i.e., 29% and China i.e., 21% followed Australia, Singapore, UK i.e., 6%, and 44% from rest of the 19 countries, as shown in Figure 5.

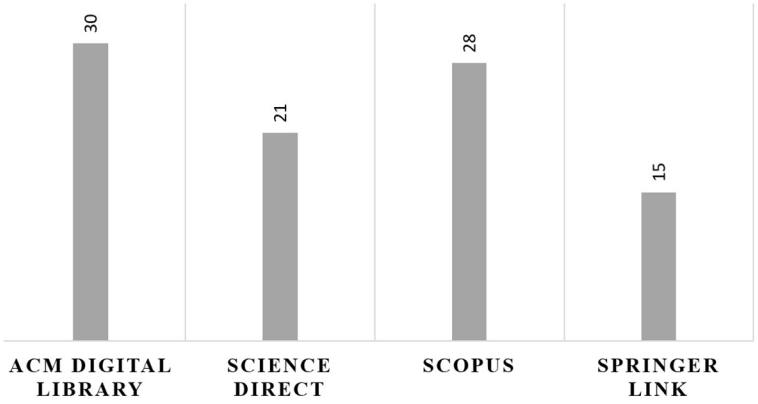

Figure 4. Publication sources of selected studies

Twenty-four countries are represented in the study with eight global studies involving all continents where less work from the continent of Africa. The study modulates findings from selected studies that provide a predominantly global view of the practice of motivational theories in CS.

5. RESULTS – MOTIVATIONAL THEORIES IN THE CS

Figure 6 summarizes our research questions and provides an overview to comprehend our study. 91 selected studies that are cited in results are included in 'Appendix A'.

The aim is to investigate the three research questions, see section 3.1, which will provide a broad picture of studies conducted over a decade by reporting the trends of motivational theories in the CS environment. The selected papers were categorized based on the type of publication that has implemented the theories of motivation in a crowdsourcing environment (RQ1), and meticulously listed theories implemented and their appearance in a crowdsourcing environment over a decade (RQ2). To further the work, we investigated the studies based on the engagement models identified by T.D LaToza [36] and mapped the theories identified in RQ2 onto the models of engagement in the crowdsourcing environment (RQ3).

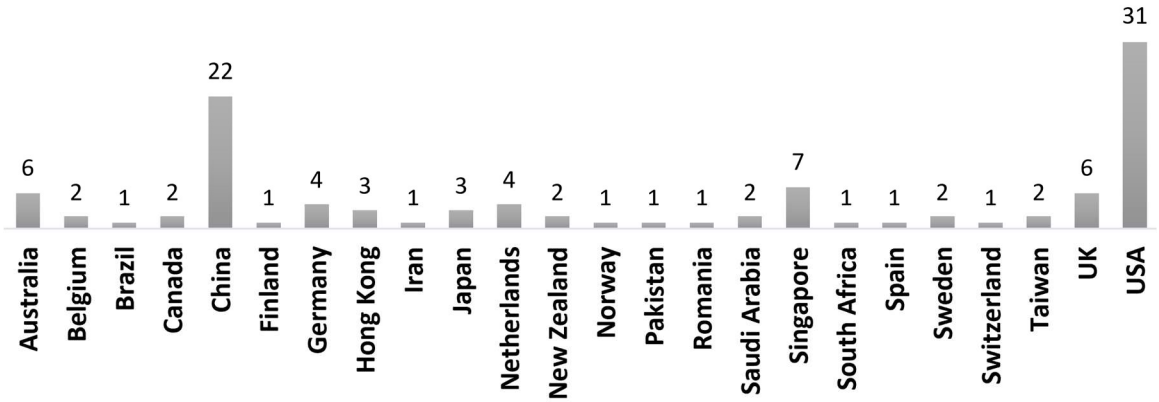

Figure 5. Countries represented in the empirical studies

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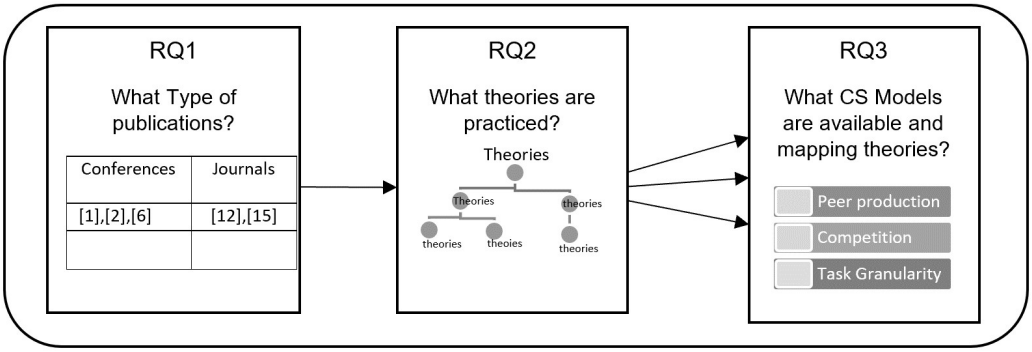


Figure 6. Relationship between the Research Questions

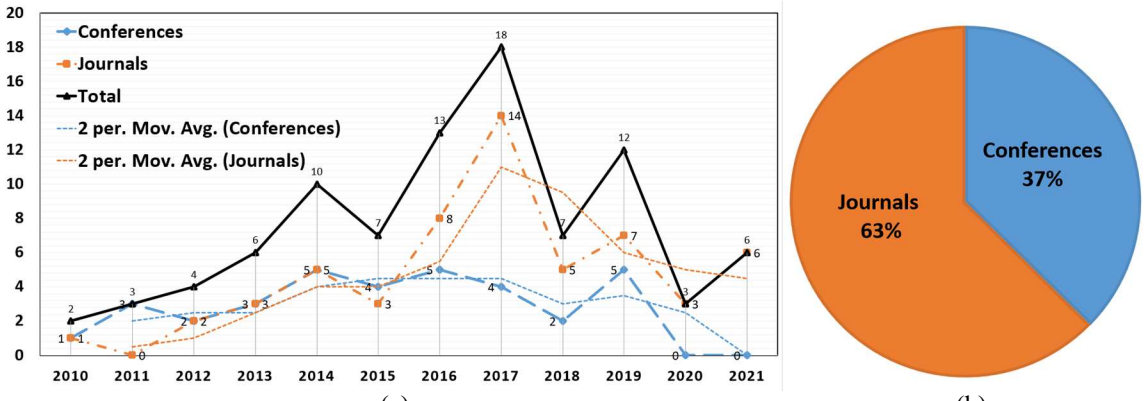
RQ1: What are the publication's trends of motivational theories in a crowdsourcing environment?

Our research identified 91 papers that have implemented the theories of motivation in the CS environment. We categorized the 91 papers to answer our Research Question 1 (RQ 1), these publications range from 2010 to 2021 and are shown in Table 4 and Figure 7(a) and (b).

We can deduce from Figure 7(b) that journal papers are more dominant than conference publications, with a periodic publication of research in journals proving more focused on the topic of motivational theories in the CS environment and the integrity of such work. Figure 7(a) shows the present overall evolution in the publications in recent years, and we have presented the data of journals and conferences over the moving average of period 2.

Table 4. Research Papers Published by Type and Year

Years	Conferences	Journals	Total
2010	1	1	2
2011	3	0	3
2012	2	2	4
2013	3	3	6
2014	5	5	10
2015	4	3	7
2016	5	8	13
2017	4	14	18
2018	2	5	7
2019	5	7	12
2020	0	3	3
2021	0	6	6
Total	**34**	**57**	**91**



(a) (b)

Figure 7 (a). Research papers on Motivational theories in crowdsourcing environment (2010 – 2019) the blue and red lines represent conferences and journal papers published respectively, whereas 7 (b). shows 42% are conferences and 58% are journal publications.

Figure 8 shows the sum of journal and conference publications from the selected databases. It can be deduced that ACM Digital has a high number of publications in conferences, as it

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registers as a very famous platform for international conferences like Computer-supported cooperative work (CSCW), Human-Computer Interaction (CHI), Economics (ICEME), and E-business, Management.

CSCW has four occurrences and the first work is seen in the year 2013, CHI occurrences are a total of three and the first work is seen published in the year 2011, ICEME has two occurrences, and the first work is seen in the year 2017. Scopus and ACM database shows the author's interest in both conferences as well as in journals with a large number of overall publications i.e. 30 and latter 29 respectively. Whereas the Science Direct database is found with no publications on conferences which shows that science direct journals are more popular among authors for research recognition and acknowledgements.

The first published work at the conference is found in the year 2011 and the journal publication is found in the year 2012 (see Table 4). Similarly, Springer shows less work published unlike other databases i.e., 11, where the first conference publication found is in the year 2012 and the first journal publication is found in the year 2013 (see Table 4).

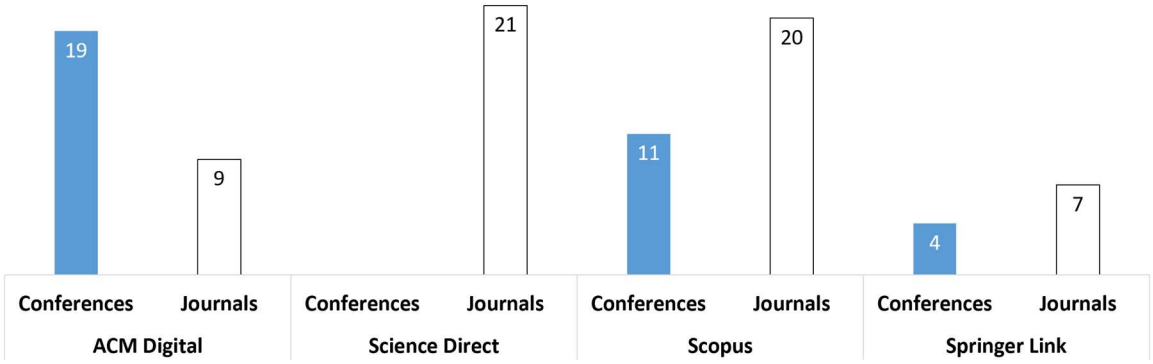

Figure 8. Publication Trends from Selected Databases

RQ2: What motivation theories are implemented in a crowdsourcing and when are their appearance in a crowdsourcing?

From the selected 91 papers identified, some theories are identified as new to CS while some have a history in other domains of research, discussed earlier in section 2. The study answers our Research Question 2 (RQ 2) and identifies 35 unique theories of motivation. Figure 9 shows the area covered against the theory and the frequency of publication, and Table 5 is drawn for better understanding.

From Table 5, it is evident that among all the theories that are implemented, the Self-Determination theory (SDT) is more popular and practiced more than others, which have a high frequency of 22. Following the SDT is Game Theory which has a frequency of 13, Gamification Theory with frequency of 9, Expectancy Value Theory (EVT) with frequency of 5, respectively. It can be reasoned that although Game and Gamification theories both have exciting philosophies engaging crowd using game elements, and the cumulative work of Social theories that are focusing on social aspect is higher in frequency, but still, researchers focus more on SDT as its focus on autonomy, competence, and relatedness which is considered a better aspect because of its drive to be fun, entertainment, etc., for research and have produced better results so far. The "Paper ID" column in Table 5 represents the selected papers with ID in red colors and are underlined have implemented two theories of motivation in their research i.e., 40, 41, and 42.

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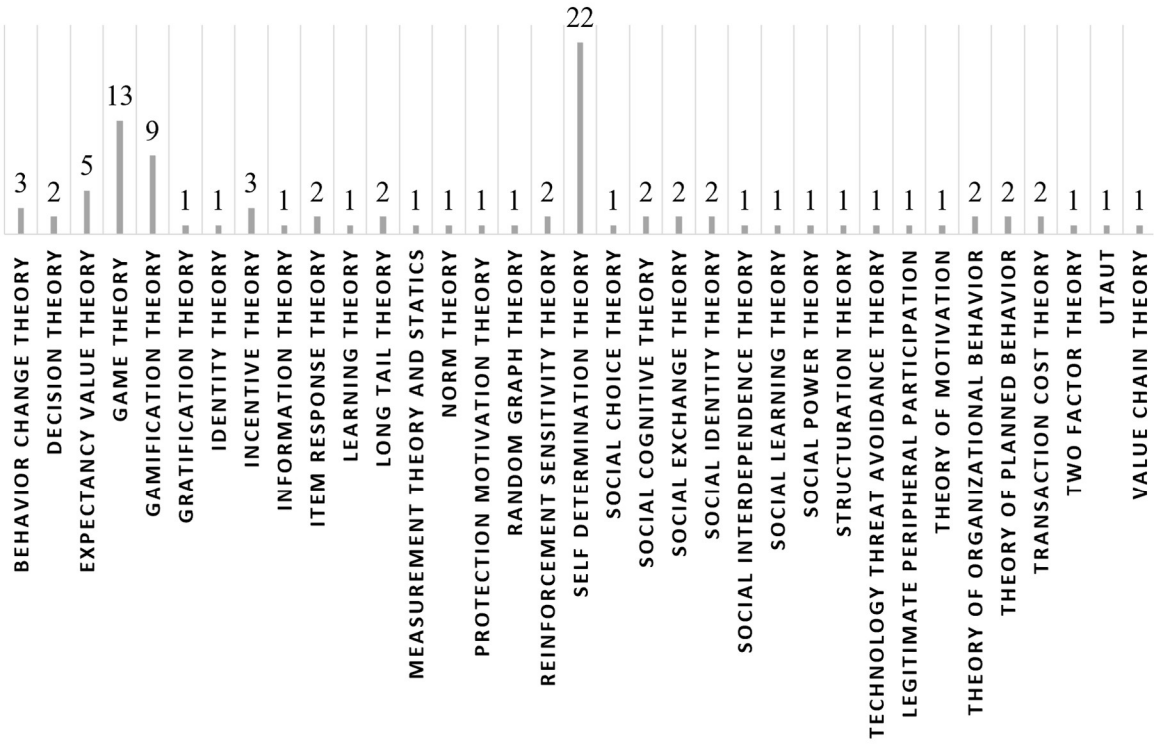

Figure 9. Theories of Motivation from Selected Studies

Table 5. Theories of Motivation in Crowdsourcing Environment from Selected Studies

S. No.	Theory of Motivation	Frequency	Paper ID (see Appendix A)
1	Self Determination Theory	22	6, 11, 28, 29, 30, 39, 40, 41, 42, 50, 55, 62, 68, 70, 71, 72, 76, 77, 88. 89, 90, 91
2	Game Theory	13	7, 9, 15, 20, 22, 31, 45, 48, 75, 80, 81, 82, 83
3	Gamification Theory	9	32, 39, 41, 42, 67, 84, 85, 86, 87
4	Expectancy Value Theory	5	46, 49, 57, 64, 69
5	Behavior Change Theory	3	17, 63, 79
6	Incentive Theory	3	47, 52, 53
7	Decision Theory	2	3, 25
8	Item Response Theory	2	19, 51,
9	Long tail Theory	2	16, 61
10	Reinforcement Sensitivity Theory	2	10, 13
11	Social Cognitive Theory	2	65, 73
12	Social Exchange Theory	2	4, 37
13	Social Identity Theory	2	21, 74
14	Theory of Organizational behavior	2	24, 56
15	Theory of Planned behavior	2	43, 54
16	Transaction Cost Theory	2	35, 58
17	Gratification Theory	1	8
18	Identity Theory	1	26

S. No.	Theory of Motivation	Frequency	Paper ID (see Appendix A)
19	Information Theory	1	5
20	learning Theory	1	33
21	Measurement Theory and Statics	1	1
22	Norm Theory	1	23
23	Protection Motivation Theory	1	44
24	Random Graph Theory	1	60
25	Social Choice Theory	1	59
26	Social Interdependence Theory	1	36
27	Social learning Theory	1	66
28	Social Power Theory	1	27
29	Structuration Theory	1	78
30	Technology Threat Avoidance Theory	1	38
31	Theory of Legitimate Peripheral Participation	1	2
32	Theory of Motivation, Volition, and Performance	1	34
33	Two Factor Theory	1	12
34	UTAUT	1	18
35	Value Chain Theory	1	14
	Total Studies	**94-3 =91**	

^ shows the repeated theories that the paper ID has implemented

Our study on Research Question 2 (RQ 2) also helped to identify the theories and how they appeared during the period as per shown in Figure 10, where the theories appeared and identified per year are a total of 35. It is evident from Figure 10, that years like 2016-2019 show more progress in the application of motivational theories in CS than the earlier years of 2010 to 2015. It can be perceived that the researchers are expected to see enhanced engagement in results by focusing more on motivational theories in CS in future studies.

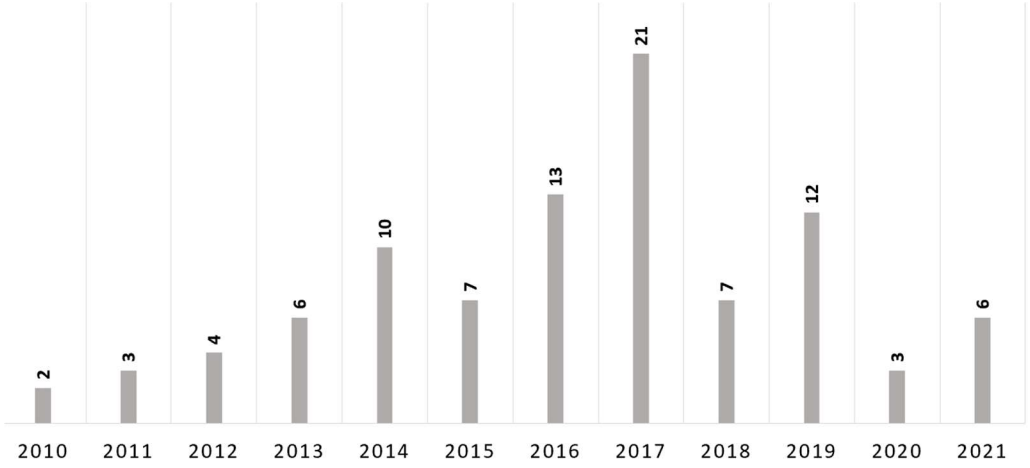

Figure 10. Frequency of Theories and their Appearance per Year (2010 -2021)

The frequency of the motivational theories implemented is shown in Table 6. Theories that have appeared only once in the table are considered nascent to CS and represented by a single asterisk and theories that are considered nascent and published in the year 2019 are represented by a double asterisk. These nascent theories are a total of 19 out of 35 theories i.e. 54.3% more theories are presented from 2010 to 2021. Therefore, it can be argued that the latest theories are being

implemented. Similarly, work to better the results are being empowered by the theories and is under consideration by various researchers. Out of these 19 latest theories, 13 were practiced from 2010 to 2018. While 6 were practiced in the year 2019, respectively.

RQ3. How the identified motivational theories can be mapped to crowdsourcing models?

Research Question 3 (RQ 3) is about mapping motivational theories onto crowdsourcing models of crowd engagement. A total of 91 studies are mapped onto the CS models, which the models are engaged by authors as a single entity or as a combination of the three of the following entities; i.e. (1) Peer Production, (2) Competition, (3) Task granularity, (4) Peer Production & Competition, (5) Peer Production and Task granularity and finally (6) Competition and Task granularity. We did not consider the final combination of Peer Production, Competition & Task granularity, which was found to be unlikely, and no study was mapped onto the such combination.

Table 6. First Appearance of the Theories in the Crowdsourcing Environment (2010–2021)

S. No	Theories of Motivation	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Total
1	Behavior Change Theory							2		1				3
2	Decision Theory	1								1				2
3	Expectancy Value Theory (EVT)			1			1		2	1				5
4	Game Theory				1	2	3	3	1	1	1		1	13
5	^Gamification Theory								2+^3				4	9
6	*Gratification Theory			1										1
7	*Identity Theory								1					1
8	Incentive Theory							2	1					3
9	**Information Theory										1			1
10	Item Response Theory				1						1			2
11	*learning Theory							1						1
12	Long-tail Theory			1		1								2
13	*Measurement Theory and Statics								1					1
14	*Norm Theory					1								1
15	*Protection Motivation Theory							1						1
16	*Random Graph Theory		1											1
17	Reinforcement Sensitivity Theory								1	1				2
18	Self Determination Theory (SDT)			1	1	5		2	6	1	2	3	1	22
19	*Social Choice Theory				1									1
20	Social Cognitive Theory				1				1					2
21	Social Exchange Theory								1		1			2
22	Social Identity Theory		1								1			2
23	**Social Interdependence Theory										1			1
24	*Social learning Theory								1					1
25	*Social Power Theory									1				1
26	*Structuration Theory							1						1
27	**Technology Threat Avoidance Theory										1			1
28	*Theory of Legitimate Peripheral Participation						1							1
29	*Theory of Motivation	1												1
30	Theory of Organizational behavior				2									2
31	Theory of Planned behavior						1	1						2
32	Transaction Cost Theory		1				1							2
33	**Two-Factor Theory										1			1
34	**Unified Theory of Acceptance and Use of Technology (UTAUT)										1			1
35	**Value Chain Theory										1			1
													Total (91+3)	94

*New theories appeared other than in 2019, ** Theories that are considered as new and appeared in the year 2019 only.
*** Three paper has implemented two theories which are shown using the symbol "^".

Table 7 is populated by mapping the theories of motivation over the models of crowdsourcing. Considering the theories which has frequency higher then 2. The trends between the 6 theories implemented make it evident that **SDT** on average has been applied by researchers in higher amounts (*M*= 3.67, SD= 1.89) followed by **Game theory** (*M*= 2.17, SD= 2.19), **EVT** (*M*= 0.83, SD= 1.07), and **Gamification** (*M*= 1.50 SD= 1.50), **Behavior Change theory** (M= 0.50, SD= 1.21 and finally Inventive theory (*M*= 0.50, SD= 0.76), respectively.

As we analyzed the studies to understand the type of work, the results are displayed as predicted earlier during the literature study. The relative frequency of the theories as shown in Figure 11 presents that most work is done using "competition", which is 40%. It can be argued that the "Competition" model has gained significant attention among the researchers over the period which is similar to outsourcing the task in hand, where the crowd instead of collaborators is treated as "competitors" and hence the selection of the winner and runner up is considered and paid accordingly.

Similarly, the following competition is "Peer Production" which is 28%. It is the best-known model [36], [104] and is practiced quite often, it focuses more on contributions and there is no reward connected to it where the crowd engages in self-efficacy, altruism, gain experience, and/or other reasons. Additionally, "Competition & task granularity" was of higher proportion which was not expected i.e. 13%, a new trend where "task granularity" is considered by researchers using the "competition" model.

Researchers are focusing more on a task that may lead to more promising results and crowd engagement. "Peer production & Competition" shows 10%, whereas, "Peer Production & Task granularity" is at 5% and "Task granularity" is at 4%.

It is evident from Table 7 that the "competition" model on average has been considered by researchers higher than other models with (*M*= 1.08, SD= 1.52), followed by "peer production" (*M*= 0.56, SD= 1.24), "competition and task granularity" (*M*= 0.36, SD= 0.86), "Peer Production & Competition" (M= 0.14, SD= 0.78), "Peer Production & Task Granularity" (*M*= 0.11, SD= 0.42) and finally "task granularity" (*M*= 0.11, SD= 0.32).

We performed further analysis on the two most independent significant models. The Post-hoc analysis using the T-test showed that there was no significant difference between "Peep Production" and "Competition". In terms of the average number of studies selected for two independent models, the t-value is -1.18. The p-value is .24. The result is not significant at $p < .05$. This result shows an appeal toward the adaptation of a certain type of crowdsourcing model. Similarly, it signifies the importance of CS models for crowd engagement.

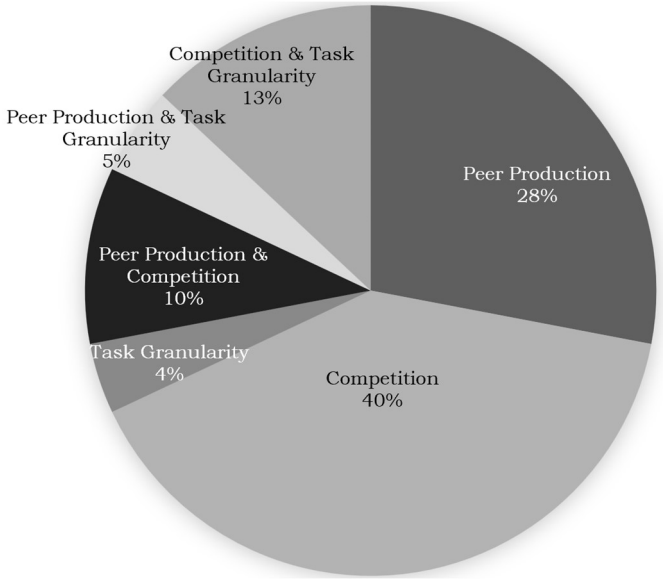

Figure 11. Mapping of study on crowdsourcing models

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Table 7. Crowdsourcing Models and Theories of Motivation

S. No	THEORY	Peer Production	Competition	Task Granularity	Peer Production & Competition	Peer Production & Task Granularity	Competition & Task Granularity
1	Behavior Change Theory	0	3	0	0	0	0
2	Decision Theory	0	2	0	0	0	0
3	Expectancy Value Theory	0	3	1	0	0	1
4	Game Theory	1	6	0	2	0	4
5	^Gamification Theory	^2+2	^2+1	0	1	1	0
6	Gratification Theory	1	0	0	0	0	0
7	Identity Theory	0	1	0	0	0	0
8	Incentive Theory	1	2	0	0	0	0
9	Information Theory	0	1	0	0	0	0
10	Item Response Theory	0	0	1	0	0	1
11	Learning Theory	0	1	0	0	0	0
12	Long Tail Theory	1	0	1	0	0	0
13	Measurement Theory and Statics	1	0	0	0	0	0
14	Norm Theory	1	0	0	0	0	0
15	Protection Motivation Theory	1	0	0	0	0	0
16	Random Graph Theory	0	1	0	0	0	0
17	Reinforcement Sensitivity Theory	0	2	0	0	0	0
18	Self Determination Theory	6	6	1	4	2	3
19	Social Choice Theory	0	1	0	0	0	0
20	Social Cognitive Theory	2	0	0	0	0	0
21	Social Exchange Theory	0	1	0	1	0	0
22	Social Identity Theory	1	0	0	0	0	1
23	Social Interdependence Theory	0	1	0	0	0	0
24	Social Learning Theory	1	0	0	0	0	0
25	Social Power Theory	0	0	0	0	0	1
26	Structuration Theory	0	0	0	1	0	0
27	Technology Threat Avoidance Theory	1	0	0	0	0	0
28	Theory of Legitimate Peripheral Participation	0	0	0	0	1	0
29	Theory of Motivation	0	1	0	0	0	0
30	Theory of Organizational Behavior and Distributed Computing	1	0	0	0	0	1
31	Theory of Planned Behavior	2	0	0	0	0	0
32	Transaction Cost Theory	0	2	0	0	0	0
33	Two Factor Theory	0	0	0	0	1	0
34	UTAUT	0	1	0	0	0	0
35	Value Chain Theory	1	0	0	0	0	0
	Total (91+3) = 94 Paper	**26**	**38**	**4**	**9**	**5**	**12**
	Mean	0.56	1.08	0.11	0.14	0.11	0.36
	Std Div σ	**1.24**	**1.52**	**0.32**	**0.78**	**0.42**	**0.86**

^ Three papers have implemented two theories

6. DISCUSSION

This section discusses the literature from our study and further elaborates on the results presented in the earlier section, which will help us to understand the theories and their underlying construct in the crowdsourcing environment.

6.1 RQ1 Trends of Publication

The study of the 91 papers was identified and divided into two categories i.e. conferences and journals. It is observed that the papers published during the period (2010-2021) have more publications presented in journals than in conferences, as shown in Figure 7 (a) & (b).

The high presence of the journals connotes that research published in journals proves more focused on the topic of motivational theories in CS and hence the integrity of published work is higher than that of conference publications. However, it is quite evident from the publications that there are very high-rated conferences were also present in the selected study, for instance, the publications by [75], [105], [106] are presented in CHI, [74], [107]–[109] have presented their work in CSCW [58], [95], [110] and have presented work in IEEE conferences. Figure 13 presents results that demonstrate the overall publications of conferences and journals and it is evident that the conference publications have reached a maximum of 5 and journals reached a maximum of 19.

Figure 12 also shows the growth in publications from 2010 to 2021. Researchers are more focused on implementing the theories of motivation and testing them in the crowdsourced environment. The rise of journal publications can be seen from the year 2013 onwards.

6.2 RQ2 Theories of Motivation in Crowdsourcing

Unique theories which were identified from the 91 papers are tabulated in Table 7. After a meticulous study and understanding, we consolidated the theories into 36 theories. It is found that some of the theories are continuum or practiced using continuum features of the theory. Many researchers have used the continuum of the original theory, for instance, Crowston [11] has used the helping behavior theory which is a continuum of behavior change theory, Pang [103] has used the Principle agent theory, and Goes [17] has used goal-setting theory which is a continuum of Incentive theory.

Similarly, others have used the continuum features of the theories, like Posch [111] and M.J Prince [112] addressed the continuum features of SDT, Kim [68] addressed the continuum features of Gamification theory, which are further elaborated by F. Guay [113] and they addressed them as each feature of motivation is correlated with different results and success.

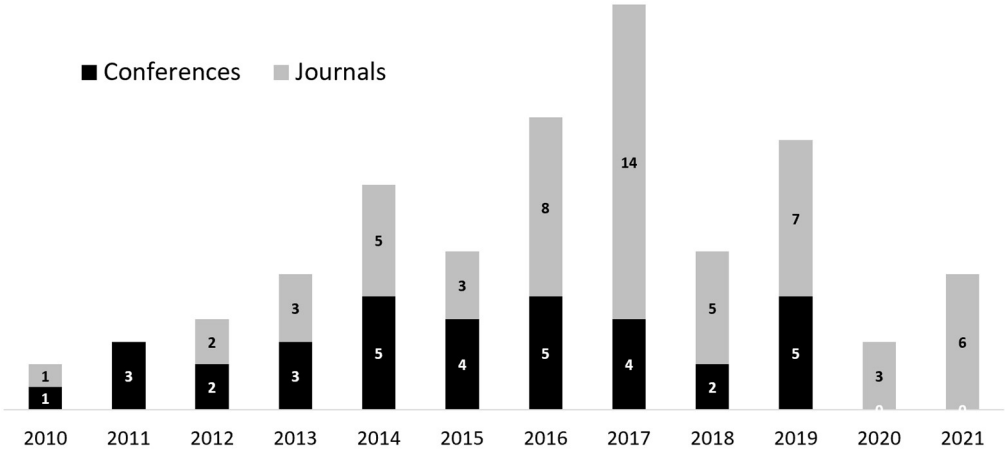

Figure 12. Shows the conference and journals publications per year

Secondly, it is evident from Figure 10 that there is an exponential rise in the application of theories in a CS environment over the period (2010 - 2021). These theories may not be new to some as they may be abundantly used in other domains of study but for the CS environment, they are considered new and nascent. The popularity of the theories can be judged from Table 6 where it is evident that SDT is practiced at 22.7%, Game theory at 13.4%, Gamification at 9.3%, and finally EVT at 5.2%, respectively. It can be argued that other than the theories, SDT and Game theory is seen rigorously used over the past years which proves the behavior of researchers for better engagement and results than others. We expect that the rise of new theories may have a better effect on the factors considered pitfalls by the two.

New and nascent theories, presented in 2019 like Informational theory [114] have gained popularity where information dissipation and verification are of importance, Social independence theory [115] helped in establishing contests and gathering CS creative ideas online, two-factor

theory [29] helps find influencing feature for the crowd, and Value chain theory [116] has established its importance in education and industry. Hence it can be deduced that such theories had a bright future but what is more important for researchers is to rigorously verify and prove their validity.

6.3 Crowdsourcing Models and Study

The three basic CS models; peer production, competition, and task granularity, and their combinations are shown in Table 7. It is evident that all three models and their combinations are practised in SDT, and Game theory has implemented four of these models. These models are mapped using the work of [36], which according to him, peer production focuses more on contributions and there is no reward connected to it. The crowd engages in self-efficacy, altruistically, to gain experience and/or other reasons. Competition is similar to outsourcing the task in hand, where the crowd instead of collaborators is treated as "competitors" and hence the selection of the winner and runner-up is considered and paid accordingly, and task granularity is focused on the complexity and task decomposition. We consider these models insufficient to classify the type of work of researchers and lack additional information, hence a further literature review is needed to identify the models of crowd engagement.

The "competition" model, is identified to be more popular and has gained significant attention among researchers because it focuses more on external features like awards, rewards, payment, and others. Researchers argue the rise in the trend to engage the crowd in competition because external features are more appreciated by the crowd [117] and are considered the main factors of competition [118]. "Peer production" considers the engagement of the crowd to understand human behavior where the crowd is more internally motivated and contributes to content development [81], sociability, volunteering [119], learning [62], and others. However, the researchers argue that peer production does not guarantee successful participation, and the crowd is usually motivated over a short period which may be fixed by addressing task granularity, which is found less attractive among researchers.

We can reason by looking at the frequency that a subject that needs more work is task granularity and researchers have rarely touched the task. It is found that researchers have considered the state but work on traits lacks their interest. It may be argued that trait needs more consideration of task and such activity may be considered cumbersome. However, it is germane to include a new trend where researchers are focusing the task granularity by engaging the crowd online in competition models.

6.4 Threats to Validity

The threats to our validity are two folded i.e. internal and external. Internal threats are related to the results presented in the research questions. Ideally, the literature search showed 4,654 results, however, only 673 (~15%) of the initial literature was selected and the rejected literature could not be checked due to inadequate or concealed reporting of theories.

Similarly, another threat is continuum theories and their identification out of the 91 selected papers. The selection is based on the inclusion that they all have implemented the theory of motivation. We tried our best to study and understand theories, but there may be a possibility where theories are partially analyzed and inconsistency may be present.

The third threat is of mapping the literature over the CS models of engagement. Some literature presented insufficient grounds to be included in the CS model which were further investigated for mapping. However, such literature is only 10% which is relatively small in numbers but there lies a risk of erroneous mapping and such an error rate across the publications does not compromise confidence.

Finally, the external validity concerns the selected literature. By undertaking an explicitly systematic approach to this review we hope to have included all relevant studies. Similarly, the study presented work from 22 countries where the USA and China have presented more work using theories. Therefore, we may not be able to present a global view of the study.

7. CONCLUSION

Along with the increased research trends in crowdsourcing especially with the emergence of the interwoven phenomena of engagement in crowdsourcing, the challenges of engagement have drawn researchers' attention and have lead to adopt various engagement models. This review has

identified the importance of motivational theories and models for their successful engagement of the crowd by providing a comprehensive overview, comparing different characteristics of models, examining the results on the effectiveness of the models in crowdsourcing, and highlighting future directions. We have presented new and nascent theories in the CS environment which are practiced to achieve better results. The review found a wide array of engagement model implementations in crowdsourcing literature. Our study has identified 91 relevant papers and 35 theories in which 19 of which are new and considered nascent. The findings identify potential theories that are practiced from 2010 to 2021 and mapped them onto the engagement model expanding the application of such theories in CS. The literature does not explicitly define the model of engagement and the mapping of the literature needs careful consideration. However various configurations of engagements were identified and mapped over to the models of engagement. The investigated models of engagement will answer the best engagement models. Out of all, competition and peer production models are largely implemented by the researchers, where they exploit the internal and external motivational features of the theories. The study also reports that there is a need to consider task granularity as a subject for future research. It has also highlighted some very prominent theories that have implemented the model of task granularity like SDT, EVT, Game, Gamification, long-tail theory, and others. It is argued by many that the crowd, when engaged in a task, loses motivation, and task trait is one factor that needs consideration by many researchers and needs further work. The results justify the researcher's challenges and it is reported that task granularity models are less implemented.

Finally, the study investigated the countries of origin and reported that a large number of the research work is carried out by researchers from the USA and China. We reason from the study that the developed countries are more interested in engaging the crowd. They consider that their solution will positively motivate and guide governments, organizations, industry, academia, and others to adopt, adapt and improve engagement models and direct future research.

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APPENDIX 'A' – SELECTED STUDY REFERENCES

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