An Investigation of User Interface Features of Crowdsourcing Applications

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Abstract. We investigated the user interface features of seven different types of crowdsourcing applications, which were classified along three dimensions of task type: (1) Task Structure: does the task have a well-defined solution? (2) Task Interdependence: can the task be solved by an individual or does it require a community of problem solvers? (3) Task Commitment: what level of resources is required to perform the task? Our initial investigation revealed a number of differences in the seven categories including: site searchability, online credentialing, community building features, gamification, mobility, and the use of wiki software.

Keywords: crowdsourcing, user interface, task complexity.

1 Introduction

Howe [1] defines crowdsourcing as, "the act of taking a job traditionally performed by a designated agent (usually an employee) and outsourcing it to an undefined, generally large group of people in the form of an open call." In recent years, this trend has taken several different forms and meanings, including, but not limited to: distributed labor marketplaces, online contests, customer-driven innovation and other forms of open innovation, distributed data collection, crowdfunding, crowdsharing, open-content projects like Wikipeda, among a host of other applications. Due to the breadth and variety of the crowdsourcing approaches, we created a taxonomy that characterizes the crowdsourcing applications by degree of task complexity [2]. Our view is that a primary reason for using crowdsourcing is that a company or individual wants to use the crowd to perform some kind of task on its behalf; hence a taxonomy based on task type is a natural way to classify crowdsourcing approaches.

There has been much confusion and disagreement in the literature as to what crowdsourcing is and what it is not. Some definitions of crowdsourcing have been very inclusive and have included everything from social media sites (Facebook, Twitter, and Vine) to Google flu epidemic prediction using Google search results [3]. Others have been more restrictive in limiting what constitutes crowdsourcing, like Brabham [4] who defines crowdsourced initiatives as those that are "managed from the top-down by a sponsoring organization issuing the task" (p. 121). (This definition

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excludes from consideration requestors who are individuals). We define crowdsourcing, broadly, as a four-step process in which:

1. A requestor (either an individual or organization) identifies a specific task to be performed or problem to be solved.
2. The requestor broadcasts the task or problem online.
3. The crowd performs the task or solves the problem.
4. Depending on the nature of the task, the requestor either
   (4a) sifts through the solutions and selects the best solution (Selective Crowdsourcing), OR
   (4b) aggregates/synthesizes the crowd's submissions in a meaningful way (Integrative Crowdsourcing).

Notably, while our definition of crowdsourcing is broad enough to include a wide range of activities and applications, it does not include all activities involving a crowd. For example, we exclude from consideration problem-solving that is not broadcast online (for example, a contest that is held within an organization). Furthermore, according to Step1, we require that a specific task is requested. By this restriction we do not include social media sites, or content sharing sites like YouTube.

2 Classifying Crowdsourcing Approaches by Task Complexity

We report in [2] on how we arrived at our taxonomy on crowdsourcing approaches based on task complexity. Review of the prior literature on task types and task complexity suggests highly complex tasks can be classified along a number of dimensions: (1) unknown or uncertain alternatives [5], (2) non-prescribed processes, in which there exist several ways to complete a task [6,7], and (3) multiple performance dimensions [8], among others. Campbell [9] provides a good overview of the literature on task complexity. We created a dimension, task structure, that represents in an aggregated way the degree of structure in terms of alternatives, process, and outcome measures.

To capture the nature of the group dynamics involved in the crowdsourcing approach, we drew from the literature on virtual teams. Bell and Kozlowski [10] distinguish between team processes that are low in complexity versus those that are highly complex. Low complexity team dynamics have weak linkages: "they require minimal collaboration and information sharing among members" (p. 19). Many of these team tasks are structured such that activities are performed separately by individuals and then combined into a finished product. In contrast, high complexity team dynamics are more challenging, involving "greater levels of synchronous collaboration and information sharing among team members" (p. 19). Because of this, such tasks require collaborative and intensive workflow arrangements. Again, to keep our model simple, we created a binary dimension to represent task interdependence: independent tasks vs. interdependent tasks.

	Independent Tasks (Individuals)	**Interdependent Task** (Virtual Communities)
Well-Structured Tasks (The solution to the problem is well-defined.)	**I. Contractual Hiring** *Low Commitment*: Human intelligence tasks Crowdsharing marketplaces *High Commitment*: Online employment platforms	**II. Distributed Problem-Solving (Coordinated Interdependence)** *Low Commitment* Geo-located data collection Distributed knowledge gathering Crowdfunding
Unstructured Tasks (There is no known or well-defined solution to the problem.)	**III. New Idea Generation – Solo** *Low Commitment*: Consumer-driven innovation *High Commitment:* Online problem-solving platforms Contests	**IV. Collaboration (Conflicting Interdependence)** *Low Commitment:* Real-time idea jams *High Commitment:* Open source software development Open source design of hardware Open content projects

Fig. 1. A Task-Fit Model of Crowdsourcing (Source: See [2])

Finally, we added a third dimension, task commitment (or task difficulty) to our final taxonomy. The literature suggests that task difficulty is related to, but not synonymous with task complexity. Some tasks, without necessarily being complex, are difficult because they require a high effort to perform [9]. Other tasks are difficult because they are complex.

In the end, our final taxonomy is based on three dimensions of task complexity (see Fig. 1):

(1) Task Structure: Is the task well-defined or does it require a more open-ended solution? (well-structured vs. unstructured)

(2) Task Interdependence: Can the task be solved by an individual or does it require a group of problem solvers? (independent vs. interdependent)

(3) Task Commitment: What level of effort and resources are required to perform a task? (low vs. high)

Although the three dimensions, taken together would result in eight (2X2X2) categories, we discovered that well-structured and interdependent tasks were, by nature, low commitment. Hence our final taxonomy contains seven categories.

3 User Interface Features of Each Category of Crowdsourcing

In this section, we explore one representative example in each crowdsourcing task type, and investigate user interface features associated with each. Some of the user interface characteristics that we explore in this section include the following: searchability of information, stickiness of website (i.e., the use of gamification and other

techniques to create an addictive user experience), online credentialing, community building, features of a mobile phone user interface, the ability to learn from crowd reports, and other features.

3.1 Contractual Hiring, Low Commitment

Tasks that fall in Quadrant I (see Fig. 1) are well-structured and solved independently. For example, Amazon Mechanical Turk is a marketplace in which anyone can post tasks to be completed and specify a price to be paid for the successful completion of them [11, 12]. The motivation behind this system is to allow human users to complete simple tasks (known as human intelligence tasks or HITs) that would be difficult for computers to complete—e.g., tagging video images, judging the relevance of search results, transcribing podcasts. In general, the type of tasks publicized in Mechanical Turk require little time and effort to perform.

With 265,965 HITs posted (as of 2/5/2014), an important and necessary user interface feature is to have extensive searching capabilities. Mechanical Turk allows you to search and filter by a number of criteria, including reward amount, date created, expiration date, time allotted, and title (of task). An interesting feature is that the user interface allows for online credentialing: some HITs are available only to users with certain qualifications. You can earn qualifications by taking online tests to demonstrate your ability to give high quality answers. In terms of site stickiness, a dashboard enables you to display a list of daily activities and earnings, along with the number of HITs that were submitted, approved, rejected, or pending that day. This ability to monitor and track your progress, can keep some users "hooked" to the site.

3.2 Contractual Hiring, High Commitment

Elance bills itself as the world's leading online employment agency. The Elance website allows businesses to post jobs and search for freelance professionals. Through the web user interface, you can evaluate contractors applying for jobs. Unlike Mechanical Turk, Elance specializes in tasks requiring more skillsets to complete and more effort to perform—e.g. design a web site, write an article, or write a program.

Because of the large database of online jobs available, Elance allows you to easily search for information. For instance you can search by job categories (IT, Web, & Mobile, Data Science, Writing, Translation, Design & Multimedia, and so on). The site has several features that promote stickiness and community building. For example, you can track job progress, set milestones, view works-in-progress, and video-conference with other freelancers. In addition you can rate jobs and post comments about freelancers you have used in the past. Job seekers can post a "portfolio" of work—e.g. if you are a graphic design artist, the user interface enables you to upload samples of your work. Elance skill tests are offered in a variety of areas including IT and Programming, Writing and Translation, Design & Mulitimedia. For example, in Design & Multimedia, you can take tests in 3D Modeling, Adobe Photoshop, Pagemaker, and a host of other topics.

3.3 Distributed Problem-Solving (Coordinated Interdependence)

In this quadrant, crowd individuals perform a well-structured task, and still act independently, but the outputs of the individual's activities are combined and aggregated (i.e., coordinated) in some meaningful way. We have found that tasks that fall in this category tend to be low commitment by nature [2]. We discuss two types of crowdsourcing applications: (1) geo-located data collection and (2) distributed knowledge gathering.

Geo-located Data Collection. Waze is a GPS app that enables a community of drivers to share real-time traffic and road information. Because it involves the reporting of geo-located data, it is most effective on a GPS-enabled mobile device such as a smartphone or tablet computer. In fact, almost all crowdsourcing applications that require geo-located data collection are primarily used on mobile devices (another good example is ATT's Mark the Spot, an app that lets you report wireless coverage problems). All this real-time information is aggregated so that the GPS knows how to re-route you to a different route based on traffic reports and other road alerts reported by the crowd. The ability to learn from crowd reports is a key user interface feature of Waze.

The user interface enables you to very easily report events with one or two mouse-clicks (the driver—in some cases the passenger—of the vehicle must be able to do this very quickly while driving). A Report icon on the main screen quickly takes you to a Report screen, which contains a number of icons, representing the different types events you can report: traffic jam, police, accident, and hazard. An interesting feature is the Map Issue icon, which lets you report maps errors, and other driving errors as a result of receiving wrong driving instructions—hence Waze, unlike a traditional and more static GPS system, is able to correct errors in real time.

In terms of building community, Waze offers a number of features: Because of the immediacy of the app, and its ability to detect real-time events, Wazers feel a part of a community of drivers united by their mutual hatred of traffic. You can also connect to Facebook to arrange meet-ups with your friends. Other features promote stickiness: map chat lets you chat with other Wazers; a gas option shows the prices of gas around your area; and a points system allows you to earn a higher status, the more you use Waze .

Distributed Knowledge Gathering. Like Waze, CureTogether involves distributed data gathering, except that it does not collected geo-located data. CureTogether is a web site where patients around the world can share quantitative information on their medical conditions. By gaining access to millions of ratings reported to the web site, patients can learn from the experiences of other patients suffering from similar medical conditions.

The user interface enables you to browse from over 500 conditions organized topically—e.g., mental health, digestive system, eyes and ears, cardiovascular, and men's health. By clicking on a particular condition, you can get statistics on symptoms, treatments, side effects, and causes. For example, by clicking on treatments you can

retrieve statistics on average effectiveness, popularity, and % reporting major improvement (rank-ordered from top to bottom). One information graphic—a 2D plot—helps you visualize the effectiveness versus the popularity of treatments. In terms of building community, members of CureTogether can connect with other members suffering from a similar condition.

3.4 New Idea Generation – Solo, Low Commitment

These crowdsourcing approaches, which fall in Quadrant III, involve unstructured tasks in which individuals in the crowd, working solo, generate new ideas. Low commitment task examples include companies that use the Internet to listen to customer input on new product ideas and offerings, what is often referred to as customer-driven innovation. A good example is Dell's IdeaStorm, which was launched in 2007 to allow Dell to understand and gauge which ideas are most important by their customers.

The user interface allows visitors to easily search for ideas by different categories, for instance: Product Ideas (Accessories, Desktops and Laptops, Mobile Devices, Operating Systems, etc.) as well as Topic Ideas (Education, Enterprise, Gaming, Small Business, and so on). Visitors can comment on other's ideas, as well as vote on them. Gamification techniques are employed so that contributors can earn points for their ideas, with the top recent contributors displayed on the home page.

3.5 New Idea Generation – Solo, High Commitment

High commitment tasks typically follow one of two approaches: (1) direct compensation for online problem-solving or (2) contests.

Direct Compensation. One of the most well-known online problem-solving platforms is Innocentive. InnoCentive is an open innovation and crowdsourcing platform that enables organizations to solve their R&D problems by connecting them to diverse sources of problem-solvers throughout the world. When a company internal R&D department is stumped by a problem, it can post the problem on Innocentive for thousands of professional or amateur scientists around the world to solve it. The company then pays the problem-solver in exchange for the intellectual property. Successful solvers have earned awards of $5,000 to $1 million [13]. (They also allow for simple ideation challenges, so the commitment level can be low or high).

The user interface (i.e., the Challenge Center) is organized around searching for problem-solving challenges. A visitor can search by area of expertise, award amount, company, and submission type (individual solver vs team). The system is gamified in that winning solutions are posted and featured on the site (this enables winning solvers to promote themselves in the community). Community building is promoted in that you can join discussion groups and meet like-minded problem-solvers.

Contests. A well-known example of an online contest is Cisco's quest to find a new billion-dollar business. The business idea had to fit into the company's strategy and take advantage of the company's lead in Internet technology. More than 2,500 innovators from 104 countries submitted 1,200 ideas in pursuit of a prize of $250,000 for the best business idea [14].

A technology platform enabled allowed people to sign up, contribute ideas, and comment and vote on everyone else's submissions. Although this platform assisted Cisco in selecting a winning submission, the winnowing process turned out to be time-consuming and laborious: "The evaluation process was far more labor-intensive than we'd anticipated; significant investments of time, energy, patience, and imagination are required to discern the gems hidden within the rough stones" [14, p. 1]. For many unstructured, high commitment tasks, it is very difficult to automate the process of selecting the best solution with a computer alone; human leadership and intervention is usually necessary.

3.6 Collaboration (Conflicting Interdependence), Low Commitment

While Quadrant III (see Fig. 1) can be solved by individuals working independently, Quadrant IV collaboration problems require crowd members to cooperate at some level and set aside their individual differences and competitive impulses. We refer to these problems as "conflicting" interdependence because diverse individuals working together may sometimes disagree with one another. In crowdsourcing initiatives, mechanisms must be in place—be they technological or otherwise—to resolve these differences.

An example of a low commitment, collaboration task is IBM's Innovation Jam. In 2006, IBM which brought together more than 150,000 participants from 104 countries and 67 companies, to promote innovation at IBM. Over two 72-hour jam sessions, participants posted their ideas on how IBM's research technologies could be used to solve real-world problems, and find new business opportunities [15].

To conduct the jam sessions, IBM used a technology platform that enabled participants to easily post ideas, and see what others were saying in real time. (Interestingly, IBM neglected to include an option that allowed participants to vote on and view what the most popular ideas were; their belief was that there was a danger of good ideas being lost, if participants focused on only the most popular ideas). A few problems about conducting the jam sessions are noted by Bjelland and Wood [15]. One was that it was very difficult to guide conversations—the freedom of the jam made it difficult for a human moderator to exert influence on the online posts. A second problem is that it was rare to find participants who built on, and refined previously posted suggestions—there was a tendency to add a new post without much reflection on what was said previously. Future work might look at how a technology platform can better support a jam session, and facilitate the difficult task of synthesizing and choosing from thousands of separate ideas. (As it turned out, some 50 senior executives spent a week reviewing the output of the brainstorming session, in order to synthesize it into 31 "Big Ideas.")

3.7 Collaboration (Conflicting Interdependence), High Commitment

Open source software development, and open content projects fall in this category of crowdsourcing approaches. Here we focus on the mechanisms that Wikipedia uses to keep its online encyclopedia up-to-date.

Wikipedia, the largest and most popular wiki and encyclopedia in the world, is a good illustration of how a large crowdsourced project can be managed by the crowd. At the top of any Wikipedia page is a tab that says, "Edit this page." Using this tab, any visitor at all can edit any page. How does Wikipedia, then, prevent errors and vandalism from occurring on its thousands of pages if it is possible for anyone at all to edit content? The crowdsourcing effort is largely managed by a team of editors, and administrators who work together to fix errors and resolve any conflicts that might arise [16,17]. When you enter a change, a community of editors monitor and watch out for the change. If they are OK with what you wrote, then the change will remain there unaltered. On the other hand, if what you wrote is vandalistic or incorrect in some way (e.g., full of grammatical errors), it is likely that someone will quickly fix the change. In this way, Wikipedia is a self-monitoring, self-correcting, and self-governing system that requires very little top-down management.

An important point to underscore about a high commitment collaborative project like Wikipedia is that the Wiki software and user interface features allow for easy editing and updating of the content, but the process of managing the potential conflicts must still be performed by human editors and administrators.

4 Discussion and Conclusions

Our initial investigation on the seven types of crowdsourcing revealed several differences and similarities in terms of user interface features. Among the more important findings of our investigation were the following:

Searchability for Information. In all seven types of crowdsourcing, the user interface allowed for easy searching of information**.** The ability to quickly locate information generated from the crowd is a key feature of all types of user interfaces.

Community-Building Features. We found community building features important in almost all forms of crowdsourcing. One exception was well-structured, low commitment tasks that involved some form of direct compensation. This type of crowdsourcing appears not to require community building features as much as the others.

Site Stickiness and Gamification. Gamification techniques were used extensively throughout the different types of crowdsourcing. One exception was the Quadrant IV (Collaboration) examples.

Online Credentialing. Not surprisingly, the ability to test for skillsets was especially important in the Quadrant I (Contractual Hiring) forms of crowdsourcing in which companies and individuals are hiring individuals online.

Mobility. A mobile user interface was most important for Quadrant II (Distributed Problem-Solving) especially for tasks requiring geo-located data collection.

Wikis and the Ability to Share and Update Information. The Quadrant IV (Collaboration) crowdsourcing examples required a technology platform that supported the use of wikis to update and share information among the crowd.

Future work will involve the collection and analysis on more crowdsourcing examples. We hope to detect trends in the crowdsourcing examples, and report further on the similarities and differences among the seven approaches.

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