Paying in Kind for Crowdsourced Work in Developing Regions

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Abstract. In developing regions, the reach of crowdsourcing services such as Amazon Mechanical Turk (mTurk) has been limited by the lack of adequate payment mechanisms and low visibility amongst the crowd. In this paper, we present a commodity based model for crowdsourcing where crowd workers get paid in kind in the form of a commodity instead of money. Our model makes crowdsourcing services more visible to users in developing regions and also addresses the issue of payment. We conducted two field studies in urban India to evaluate the applicability of our proposed model. Our results show that the commodity based crowdsourcing model reached workers with very different demographics from the typical mTurk workers. We also found that users preferred to receive a commodity instead of money as remuneration.

Keywords: crowdsourcing, mobile phones, humans as pervasive computing resources, commodity exchange model, developing regions, Amazon Mechanical Turk, India.

1 Introduction

Microtasking services such as Amazon Mechanical Turk allow its users to distribute tasks to a large number of crowd workers. The majority of these tasks are those which are difficult for computers, yet simple for humans (for example, surveys, image labelling, audio transcription, and finding specific information on a website). It has been estimated that in the last decade, over 1 million workers have earned $1-2 billion via crowdsourced work allocation [2].

Microtasking platforms hold a particular promise for workers in developing regions like India. They provide workers an opportunity to earn money without being physically co-located with the work provider, and the dollar remuneration when converted to local currency also becomes quite significant [11]. A recent survey of 733 mTurk workers [11] showed that 36% of the respondents were from India. The Indian workers were young (with an average age of 26-28 years), well-educated and had a higher standard of living than the average Indian. In another study with 200 mTurk workers, Khanna et al. [5] report that nearly 80% of respondents had at least a Bachelor's degree, with another 11% currently in college. Interestingly, 92% of the

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workers had a PC and internet connection in their homes. However, those with a Bachelor's degree or higher constitute only 6% of India's working age population (15-60 years) [13] and home PC penetration in India is estimated at <10% [3]. These statistics suggest that the reach of microtasking services has been limited to the educated elite in developing regions. We believe that there is tremendous untapped potential for microtasking services in developing regions if they are made more pervasive and available to a larger number of workers. We argue that there are three major reasons why microtasking services have not been able to reach more workers in developing regions:

(*i) Access*: Most microtasking platforms are hosted on the internet. Internet penetration in developing regions like India is low, as a result of which a large number of potential workers are unable to access microtasking services. On the contrary, penetration of mobile phones in developing regions is very high (64.7% of the population in India as per the latest statistics [14]) which make them a promising platform to address the issue of accessibility of microtasking services.
ii) Visibility: The visibility of microtasking services is also quite low in developing regions, and the potential workers are not aware of them. If some of these services can be brought from the digital world into the physical world, it may increase their awareness among the workers.
iii) Payment: A major problem impeding the growth of microtasking services in developing regions is the lack of adequate payment mechanisms for the crowd workers. More than 60% [8] of the Indian population do not have a bank account, which makes it difficult for a microtasking service to pay them for their work via the traditional banking system. An obvious solution to this problem is to give the workers some commodity or service in return of the work. However, the choice of the commodity should be such that it is useful for the worker immediately or in the near future. For example, a microtasking service named txteagle [4] provides mobile phone airtime as the commodity in exchange for work. However, one can argue that the workers may not be in the need for mobile airtime every time they do the work, and as subscribers in India are unable to convert airtime to cash payouts, this leads to lower participation in the microtasking service.

The problem of *Access* has been addressed by initiatives like txteagle [4] and MobileWorks [6] which push microtasks to the worker's mobile phone using SMS or the USSD protocol. In this paper, we investigate the applicability of an alternate model of crowdsourcing which address the aforementioned problems of *Visibility* and *Payment* with existing crowdsourcing systems. We propose a model in which workers are presented with the opportunity to do microtasks whenever they feel the need for a commodity, and on completion of the microtasks, they get their desired commodity as remuneration. At a strictly objective level, it is effectively a change in the currency of remuneration, but subjectively we hypothesize that getting a commodity 'for free', particularly at the time when said commodity is to be consumed, is perhaps a better motivator to do the microtasks than simply working for money.

We present two field studies to explore the applicability of our proposed model in real-life scenarios. Results show that our proposed model increases the reach of microtasking services to those user segments which are less likely to join existing microtasking services like mTurk. We also found that users have different motivations

to work on microtasks such as "desire to earn", "desire to save", and "desire for commodity". The conventional crowdsourcing models only appeal to their "desire to earn", while our proposed model can fulfill all three desires.

In the next two sections, we describe our crowdsourcing model and give an overview of the related work. Then, we describe evaluations with user populations in urban India and report their results before finally outlining and discussing the key findings.

2 Model Description

Our proposed commodity-centric crowdsourcing model (CCCM) assumes that there is a repository which consists of microtasks contributed by various work-providers. In the conventional crowdsourcing model (for example, mTurk), crowd workers will go to this microtask repository and express a desire to do tasks. The repository will first collect information on the background and qualifications of the workers and then push appropriate tasks to them.

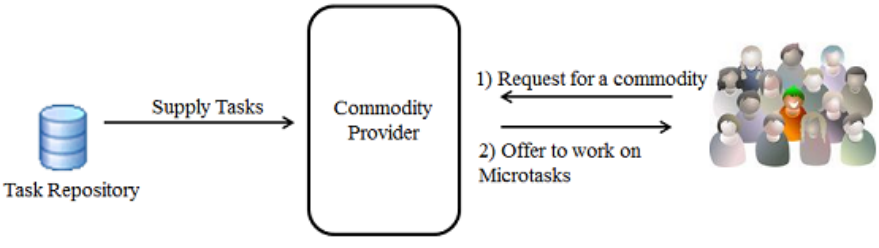


Fig. 1. Overview of Commodity-Centric Crowdsourcing Model

In CCCM (see Fig. 1), the microtasking repository does not interact with the workers directly, but through an intermediary we call a *Commodity Provider*. A Commodity Provider can be any entity which offer a commodity to the worker, and in return ask the workers to perform microtasks. A commodity may comprise of a good or a service. For example, an auto-rickshaw[1] driver can be a Commodity Provider who provides auto-rickshaw service for free or on a discounted price in return for the performance of some microtasks, or the ACM digital portal can be a Commodity Provider which provides scientific articles to a student worker on completion of a microtask. It's important to note that at some level a commodity could be equated to cash, since most tangible goods and services essentially have a monetary value in most societies. Of course, the nature of the commodity might well determine how easily a cash equivalent can be determined; for example, a discount on an auto-rickshaw ride has an obvious cash equivalency. However, we believe that by casting the compensation as a commodity in terms of how it is described and provided, it enables users to not think of it in direct monetary terms and as such might well

[1] An auto-rickshaw is a three-wheeled vehicle which is very common for public transport in India. They offer a cheaper alternative to taxis and attract a large number of passengers every day. There are more than 100,000 auto-rickshaws currently operating within the city of Bangalore alone. (http://en.wikipedia.org/wiki/Auto_rickshaw).

ascribe a value to the commodity that they would not typically ascribe to the monetary equivalent. The findings of recent studies from economics literature [17, 18] also highlight the advantage of commodity compensation over its monetary equivalent.

When users (potential crowd workers) approach a Commodity Provider, they are given an option of doing a microtask to get the commodity, or they can choose to pay for the commodity as they would normally do. If they decide to do microtasks, the Commodity Provider fetches tasks from the repository and passes them to the workers. The credit earned by the workers after completing the task is exchanged for the commodity being offered by the Commodity Provider. In case the credit earned is less than the value of the commodity; the workers get a discount on the commodity proportional to the credits earned by them, and they pay the remaining amount in cash. Later, the microtasking service pays money to the Commodity Provider in return of the task credits, along with a small commission for its services.

Because a crowd worker will expect to get instant remuneration for his/her work, this model is better suited to those tasks which can be done in spurts (surveys, image categorization) and do not require a formal verification. For example, crowd workers may not prefer doing an essay writing task which requires quality checks from the task giver, resulting in a delay in remuneration.

While CCCM can be applicable to both physical Commodity Providers like the auto-rickshaw drivers and online Commodity Providers such as the ACM digital portal (for scientific articles), in this paper we are mainly interested in studying the application of CCCM in physical settings in developing regions. We argue that the integration of CCCM with physical Commodity Providers can increase the visibility of microtasking services. The Commodity Provider can leverage the high mobile penetration in developing regions to distribute tasks to the workers on their mobile phones, hence solving the problem of *Access*. CCCM also address the problem of payment mechanism to a great extent: instead of paying all the crowd workers, the microtasking service only has to pay the Commodity Providers which are far fewer in number than the crowd workers.

3 Related Work

Perhaps the closest and most relevant work related to our proposed model is reCAPTCHA [9] which asks a user of a system ‘X’ to solve image captchas in order to get access to the system X. In the context of our model, the system X is the Commodity Provider and ‘access to X’ is the commodity for which a user will do the image captcha task. In contrast to reCAPTCHA, we are inclined to explore the applicability of the CCCM model in physical settings in developing regions to solve the problems of *Visibility* and *Payment*.

There has been some interesting work on developing microtasking services that specifically target workers in developing countries. txteagle [4], started in Kenya, is one such service which makes use of standard channels like text, voice, and USSD to distribute and administer tasks to the workers. Sample tasks include software localization, evaluation of search results, categorization of blog sentiments, and market research. Payment to the workers is made in the form of mobile airtime. MobileWorks

[6] is another such service which uses a web-based mobile application to distribute OCR tasks and pays its workers in cash. SamaSource [12] is a non-profit organization seeking to empower workers in developing countries. They recruit and train the workers (women, youth and refugees) to work on microtasks and earn their livelihood. Ushahidi [7] is an open source platform from Kenya, which allows users to crowdsource crisis information through text messaging using a mobile phone, email, and the web.

In addition to these there are more than 50 other companies running online task marketplaces of various kinds [2]. In addition to mTurk, some examples include CrowdFlower, CrowdSifter, CloudCrowd, LiveWork, LogoTournament, CastingWords, and SmartSheet which draw workers from developing countries. All the listed examples are internet based solutions and fail to tackle the issues of *Access* and *Payment*.

Among all the crowdsourcing services mentioned above, txteagle makes use of mobile phones to distribute tasks which makes it more accessible to the workers in developing regions. It pays the workers with mobile airtime to solve the *Payment* problem. However, txteagle's approach is different from our proposed Commodity-Centric Crowdsourcing Model (CCCM) in many ways. At a high level, txteagle follows the mTurk-like model where users would approach the microtasking service, and work on some tasks to get paid. On the contrary, in our model users work only when they need a commodity. CCCM makes sure that there is a need for the commodity before pushing the tasks to the workers whereas in txteagle tasks are pushed irrespective of the need for the commodity. Apart from solving the issue of payment, we conjecture that our model would expand the range of the crowdsourcing workforce by bringing in workers of different demographics.

Finally, there has been work around bringing microtasking services into the physical world. Florian et al. [1] developed a mobile application to facilitate location based crowdsourcing. Other researchers [10, 15, 16] discuss different approaches with sensing devices like smartphones for getting people at some specific location to contribute to microtasks.

4 Evaluation

We explored the effectiveness and applicability of the CCCM model in developing regions via two user evaluations in urban India. The first (primary) study is focused on evaluating the basic premise of the CCCM model with potential target populations, while the second (ancillary) study is a follow-up intended to see if the CCCM model might also apply to those populations who might have previously participated in more conventional mTurk like activities online.

4.1 Study 1

The primary focus of our work is to determine whether or not the CCCM model is viable, and to gauge its potential amongst user populations that currently do not partake in conventional crowdsourcing activities. One example of such a user population are people in the lower- to middle- income demographic in urban Indian cities who have some literacy of technology but do not necessarily use it extensively in their daily lives, and who might be motivated by payment by commodity. We also had to decide as to an appropriate Commodity Provider for this initial validation

study. Our main criteria in this regard was to pick a Commodity Provider who came into contact with a broad cross-section of the target user population in their daily regular business activity, and who also could capture the attention of the users for a reasonable period of time. One possible class of Commodity Provider that met this criteria are the drivers of auto-rickshaws, as they tend to cater to a broad population base and, crucially, have a "captive" audience for the duration of the rickshaw ride. As such, we enlisted auto-rickshaw drivers as the Commodity Providers, who offered auto-rickshaw service (i.e. the commodity) for free or on a discounted price and in return they asked the passengers to complete microtasks on mobile phones.

Participants. Three auto-rickshaw drivers from Bangalore, India participated in our first study as commodity providers. Two auto-rickshaw drivers were selected at random and one was selected via a referral. The drivers were male, in the age group of 25-35 years. Their monthly earnings were in the range of Rs. 15,000-20,000 (Rs. 50 = ~ USD 1). None of them were fluent in speaking English, but they could identify common English words such as 'Hello', 'Start', 'Exit', 'Right', 'Left'. Their language of communication was Hindi and Kannada (the local language spoken in Bangalore). All of them were numerically literate with an education level below 10^{th} grade. All of them owned a mobile phone, which was primarily used for dialing and receiving calls.

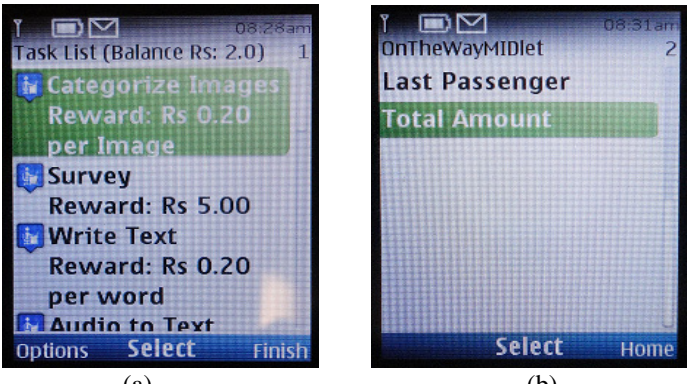
Methodology. The auto-rickshaw drivers were given a Java enabled mobile phone with a pre-loaded microtasking application (details in the next section). They were instructed to offer their passengers (crowd workers) an opportunity to avail of a discount on the journey fare in return for working on the microtasks. The total amount earned by a passenger was discounted from the journey fare. A discount on the journey fare was given only if the work done by a passenger was worth more than Rs. 5 and the maximum discount a passenger can get cannot exceed the journey fare. For their service as a Commodity Provider in our model, drivers received 20% commission on the work being done by the passenger.

We put flyers in Kannada and English in front of the passenger's seat which provided instructions to the passengers on running the microtasking application. Each auto-rickshaw driver was given a small pocket diary and was asked to maintain a record of the date of the journey, gender of the passenger, approximate age for every passenger, total journey fare, discount offered, and journey duration. Before the study, a researcher trained the drivers on using the application and ensured that they understood the purpose of the application.

We conducted semi-structured interviews with the auto-rickshaw drivers at the end of the day to get their feedback as well as the passengers' reactions towards the microtasking application. The total discount given by the auto-rickshaw drivers on that day was reimbursed to them along with the 20% commission. The dispatch of daily payment was necessary to maintain the trust of drivers in the system. Apart from the commission a fixed compensation of Rs. 500 was given to each driver for participating in the study.

The microtasking application had a data logging feature which recorded the performance of workers on each microtask. At the end of the study, we collected all the logs for analysis.

Microtasking Application. We developed a J2ME application which can be used to work on various microtasks. We deployed our application on a Nokia C2-01 which costs Rs. 4000. The application starts with a welcome screen and prompts the user to choose between two modes: Passenger Mode and Driver Mode. Fig. 2 shows the application in Passenger and Driver Modes.



(a) (b)

Fig. 2. (a) Screenshot of Passenger Mode (b) Screenshot of Driver Mode

Passenger Mode. In the Passenger Mode, users are shown a list of all available microtasks. The order of tasks in the list is chosen randomly at the start of the application so as to avoid any bias caused by the task ordering on user's task preference. Users can work on the tasks of their choice and are allowed to switch between tasks at any point of time. The asterisk key (*) is used to exit the current task and return to the task list. The top of the screen shows the *Balance* i.e. the total discount accumulated by the passenger. 'Balance' is a colloquial word for Credit in the context of mobile phones in India – the use of this word made it easier for both passengers and drivers to understand its use in context of our application.

Driver Mode. In order to reduce the learning curve for the drivers we kept the driver interface very simple with minimal functionality. In this mode, drivers can view:
a) The total Balance for the last passenger
b) The total Balance for all passengers on a day.

Choice of Tasks. We did a survey of all available tasks on mTurk and found four categories of tasks which can be supported by low-end mobile phones with basic text and voice capability:

a) Selection Tasks (ST), which require users to select an answer from a set of options,
b) Data Entry Tasks (DET), which require users to type in data from any source into the application,
c) Transcription Tasks (TT), which require users to convert speech into text, and
d) Language Translation Tasks (LTT), which require users to translate text from one language to another.

In our application, we included at least one task representing each of the four categories except Language Translation Tasks. LTT were deliberately left out because typing in a non-English language is challenging on a low-end mobile phone. Table 1 shows all the available tasks and the rewards associated with them.

The tasks on Image Categorization (IC) were borrowed from mTurk, while handwritten notes of a college student were scanned to generate images for the task IT. For the task AT, we used the audios of numbers (for example, one, two) instead of audios of English words (for example, cat, dog). This was done to ensure that proficiency in the English language does not affect a worker's performance on the task. Lastly, task SV was designed to collect demographic information like age, gender, education level, and monthly income of users. Both IC and IT tasks had 100 images each while 20 audio clips were available in AT. There was only 1 SV task with four questions on user demographics. Fig. 3 shows the design of all the four available tasks.

Table 1. Types of ST, DET and TT tasks supported by our microtasking application

Task	Description	Reward (Rs. 50 = ~ USD 1)	Task Category
Image Categorization **(IC)**	Look at an image and answer YES if it contains a person.	Rs. 0.2 per image	Selection
Image to Text **(IT)**	Type the word shown in the scanned image	Rs. 0.2 per image	Data Entry
Audio to Text **(AT)**	Convert a 5-6 sec audio to text	Rs. 1 per audio	Transcription
Survey **(SV)**	Choose an answer from multiple options.	Rs. 5 for the complete survey	Selection

It is important to note that we did not crawl mTurk or other microtasking services to import their tasks automatically into our application. Instead, we manually chose particular tasks for our application which are suitable for Indian users. For example most of the AT tasks on mTurk have audio in an American accent which might be difficult for Indian users to understand. Therefore, we chose to use numeric audio clips in an Indian accent for our AT tasks. In short, the format and categories of the tasks in our application were similar to the tasks on popular microtasking services like mTurk, but the content of the tasks was tailored to suit the target users.

As mentioned in the model description, the need for instant remuneration makes it difficult to validate the work done by the workers. However, we wanted to ensure that the passengers are doing the work seriously instead of merely guessing or randomly answering the questions in the task. To achieve this, we introduced a "qualification phase" at the beginning of each task which consisted of a few challenges whose answers were already known to us. It should be noted that the users (passengers and driver) are not aware of the qualification phase. During the qualification phase, each user response is verified and reward is credited to users balance only if the answer is correct. If users answer 80% of the challenges correctly, they are allowed to proceed to the remaining task, otherwise they are asked to work on some other task.

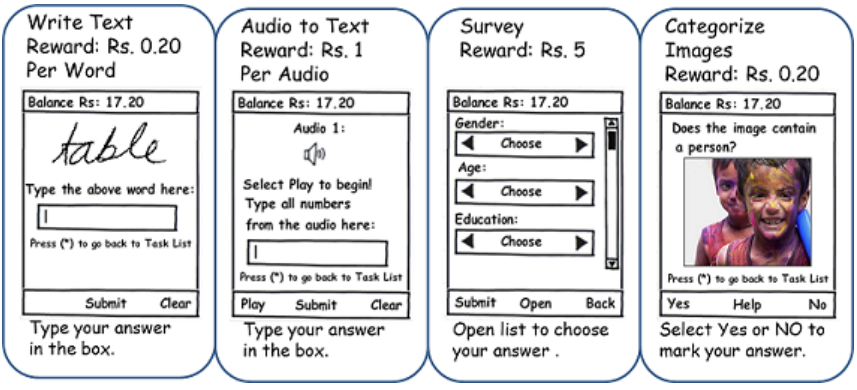


Fig. 3. Tasks available in the microtasking application

Results. The results of our study are promising and suggest that the Commodity Centric Crowdsourcing Model indeed has potential in developing countries. During the two week study, auto-rickshaw drivers offered the phone to 204 passengers for doing the microtasks, out of which 174 (25 female, 149 male) accepted the offer and availed of a discount of value greater than Rs. 5. The total discount availed by 174 passengers altogether was Rs. 4433 ($\mu = 25.4$, $\sigma = 11.9$). On average each passenger worked on ~79 microtasks to complete a total of 13,781 microtasks involving IC, IT and AT tasks. Fig. 4 shows the distribution of discounts among passengers. More than 100 passengers got a discount in the range of Rs. 15-25.

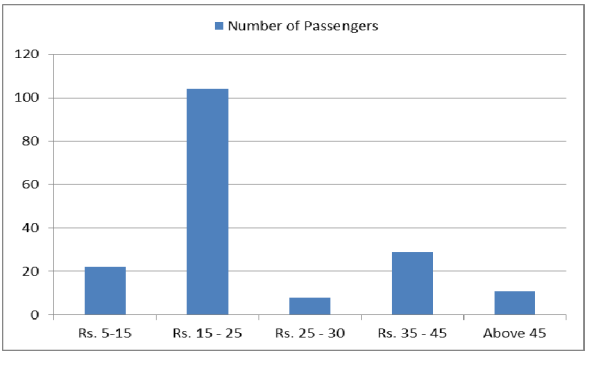
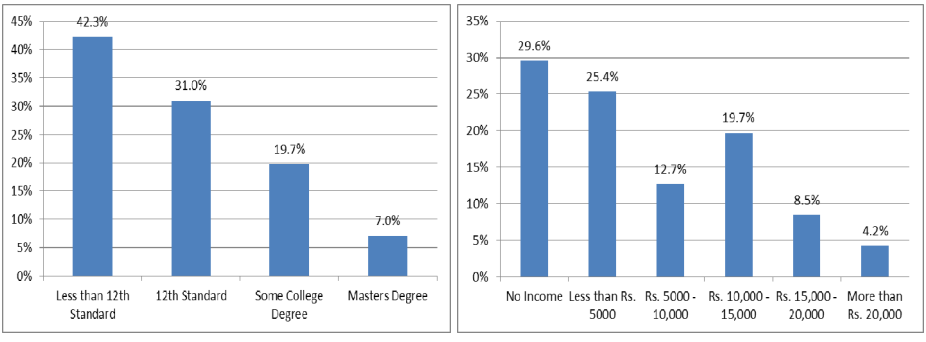


Fig. 4. Distribution of discounts among passengers (Rs. 50 = ~ USD 1)

Average journey fare and journey duration was Rs. 41.2 and 27 minutes respectively, while average time spent on microtasks was 13 minutes. As expected, we observed a strong correlation between journey fare and the discount (Pearson's $r(172) = 0.77$, $p < 0.05$). Fig. 5 shows the results from the survey task. Out of the 174 passengers 71(15 female, 56 male) passengers responded to the survey task (SV). 73% of the respondents had an education level of grade 12 or lower, and more than 50% of the respondents had a monthly income less than Rs. 5000. In contrast, recent mTurk survey of 200 Indian workers reported that nearly 80% of the respondents had

at least a bachelor's degree [5]. This result implies that CCCM is capable of reaching segments of workers who typically are not mTurk users.



(a) (b)

Fig. 5. (a) Education level of the survey respondents, (b) Monthly income of the survey respondents

Task Accuracy. The accuracy for both Image Classification (IC) and Image-to-Text (IT) tasks was 91.2% and 92.5% respectively while Audio-to-Text (AT) had an accuracy of 79.65%. One possible explanation for the low accuracy in AT can be the existence of traffic noise in the auto-rickshaw[2] which might have made it difficult for the user to listen to the audio. Fig. 6 shows a user listening to the audio inside an auto-rickshaw.

Fig. 6. A user sitting inside an auto-rickshaw is working on audio transcription and listens to the audio by keeping the phone close to his ears

Task Preference. IC and AT were clearly the favorite among the users with 66% and 64% users attempting to work on each respectively while only 24% users attempted to work on IT task. Majority of the users who started the IC or AT task carried on to

[2] An auto rickshaw does not have a door on either side which makes it difficult to avoid the surrounding noise.

finish all the available challenges[3] before moving on to another task. Only 17% of users who started working on IT carried on to finish all the available challenges for IT. The low response to IT is understandable as mobile text entry is relatively difficult and takes more time. Although AT also required users to enter text, we believe that the idea of listening to an audio clip made it more alluring for the users to do the task.

Next we discuss the qualitative findings of our study.

Change in Work Behavior of Auto-Rickshaw Drivers. On the 4th day of the study, two of the auto-rickshaw drivers told us that they prefer to serve those passengers who they thought would be able to work on Microtasks. They would often go and wait near an education institute (for example, colleges, private tuition institutes) hoping to serve a student, even if it required them to travel an extra mile to reach there. Earlier they used to wait outside temples, hospitals, shopping malls; but now they preferred to wait near places where they could find potential workers for the microtasks. Additionally, they started preferring passengers who would travel for shorter distances (30-45 minute drives) so as to reduce the loss of time in case a passenger denies working on the microtasks during the journey.

Selection Bias by Auto-Rickshaw Drivers. Auto-rickshaw drivers would often decide whether to offer a passenger a phone based on his/her age, gender, appearance, boarding point, and his/her familiarity with English. Instead of offering the phone to the passenger right at the start of the journey, the drivers chose to interact with them for a few minutes and gauge their ability to do microtasks. Only when they thought that the passenger might be able to do some tasks, they would offer the phone to him/her.

This result is particularly interesting because it shows that the drivers were using their "human intelligence" to profile the workers. Microtasking services such as mTurk also ask the users for their profile information at sign-up and assign the tasks accordingly. The drivers accomplished the same using their human intelligence.

Motivated Auto-Rickshaw Drivers. Auto-rickshaw drivers were quite excited about the system and wanted to take the full advantage of the earning opportunity presented to them. One of the drivers commented – *"God has given me this golden opportunity to earn some extra money. Now I have to work hard and earn as much [money] as I can."*

Happy Passengers. We interviewed 5 passengers (2 female, 3 male) to get feedback on the system. Three of them were studying in a college, one was doing a job and one was a housewife. All the participants said that they would like to work on these tasks mainly because a) it allows them to get immediate discount on the auto-rickshaw fare, and b) it is a good way to pass time during the journey.

Auto-rickshaw drivers often mentioned that passengers returned a small share of the discount as a gesture of regards (like a tip) towards the driver. This amount varied from Rs 1 to 10. The custom of tipping auto-rickshaw drivers is not at all common in India – the only reason why the passengers gave this tip was because they were happy

[3] As mentioned in the description of the microtasking application, the IC and AT tasks had 100 images each, while IT task had 20 audios.

with the discount given by the auto-rickshaw driver. One of the drivers quoted a passenger saying –

"I [passenger] am very happy today; you [driver] have given me a discount, I will also give you some discount."

Passengers Work More When They Are Travelling in a Group. Out of the 174 passengers, 45 passengers were accompanied by one or more people. We observed that multiple passenger trip earned greater discounts than the ones with only single passenger ($t(172) = 2.89$, $p < 0.01$). This result was surprising because we were expecting that people travelling in group would spend less time working on tasks as they might be busy talking to each other. We also observed that the passengers travelling in group solved AT with an accuracy of 89.45% which is greater than the overall accuracy of AT (79.65%). Although we do not have any data to explain the cause of this result, we believe that the presence of one more person might have enhanced the ability of the group to hear, interpret and remember the content of the audio, thus resulting in higher accuracy.

Retained Interest of Passengers. We came across 6 cases when a passenger travelled twice in the same auto-rickshaw. The auto-rickshaw drivers reported that while travelling for the second time the passengers immediately asked for the phone. Many of the passengers asked the drivers for their phone number and showed interest in travelling regularly with them.

4.2 Study 2

Results of the first study show that CCCM is capable of reaching segments of workers who typically are not mTurk users, by bringing crowdsourcing tasks to them and by commodity based compensation. This is the key result that bolsters our premise for the CCCM model. As an added exploration, however, we felt it might be useful to see if the model also appeals to a typical mTurk user (e.g. a college student). In essence, in addition to expanding the reach of crowdsourcing tasks to broader populations, as shown in Study 1, we are looking at whether a simple change in compensation from monetary to commodity might make a difference to existing populations who already partake in crowdsourcing activities. While this second study, unlike Study 1, is arguably not as crucial to assessing the validity of the entire CCCM model, it nonetheless will shed some light as to the compensation aspect of the model. Therefore, we designed a comparative user study with college students in urban India to compare their reactions to CCCM as compared to a mTurk-like interface.

Participants. Eighteen undergraduate students (5 female, 13 male) from a engineering college in Gandhinagar (India) participated in the study. Participants were aged between 19-22 years and were enrolled in a Computer Science program. The students were hired through an open call via email and public announcement. All the students lived on the college campus and each participant owned a PC with 24 hour internet connectivity. None of the participants had prior exposure to mTurk or any other microtasking platform.

Methodology. To compare the CCCM model against the conventional mTurk-like crowdsourcing model, we created two different web interfaces. The first interface (I1)

was built on the mTurk model where users can login and work on a microtask to earn money. The second interface (I2) was a meal and beverage coupon gallery, where users can do a microtask in return for a food or beverage (i.e. commodity) coupon. Because the students lived on the college campus and bought their daily meals from the college cafeteria, we decided to choose meal and beverage coupons as the commodity of our crowdsourcing model. I2 had coupons for five different varieties of food items valued in the range of Rs. 10-40. In order to get a coupon, users had to complete microtasks of equivalent value. The coupons could only be redeemed at the college cafeteria. We bought coupons from the college cafeteria in advance and gave them to the students on completion of the microtask. In both I1 and I2, the microtasks submitted by the workers were verified and they were informed about its acceptance within 24 hours of the submission.

Table 2 below shows the list of available tasks and the reward associated with each of them. All the tasks and the rewards associated with them were taken from mTurk. The Article Writing (AW) task required the worker to write a 200-300 word article on a given topic. The reward for each topic was different and varied between Rs. 10-40. In Audio Transcription (AT) task, workers had to transcribe English language audios, while the Extract text from images (ETI) task required the workers to extract textual content from an image. All these tasks can be found in abundance on mTurk and they attract large number of workers with varying skill sets.

Table 2. Available tasks in I1 and I2

Task	Description	Reward (Rs. 50 = ~ USD 1)
Article Writing **(AW)**	Write a 200-300 word article	Rs. 10-40
Audio Transcription **(AT)**	Transcribe 10 audio files each 5-7 secs in duration	Rs. 1 per audio
Extract Text from Images **(ETI)**	Identify and extract content from 20 scanned images	Rs. 0.50 per image

We did a within-subject experiment in which participants were randomly divided into two groups. For counterbalancing, one group was subjected to I1 first and I2 later (with a gap of one day in between to verify the tasks submitted for I1) and vice versa for the second group. The study was conducted in a week's time with each group being subjected to I1 and I2 for 3 days. At the end of the study follow-up interviews were conducted with all the participants. For I1, students could collect their cash earnings from the researcher after their tasks were approved. For I2, coupon codes were sent to the users on their mobile phone after the task was approved. Apart from this, each participant was given Rs. 50 for their participation in the study.

Results. Out of the 18 participants, two participants failed to participate in the second half of the study, thus resulting in a total of 16 participants (8 in each group). In I1, participants completed tasks worth Rs. 690 ($\mu = 43.12$, $\sigma = 58.49$) as compared to Rs. 1460 ($\mu = 91.25$, $\sigma = 88.73$) with I2.

Paired t-tests show a trend that users worked and earned more ($t(15) = 2.04$, $p < 0.06$) in I2 (CCCM) than in I1 (mTurk model). Fig. 7 shows distribution of tasks

completed in both I1 and I2. Extract Text from Image (ETI) got the highest hits among all the three available tasks. During the exit interviews, participants reported that ETI was the easiest of all three tasks, while Audio transcriptions (AT) and article writing (AW) were both challenging and required more time to complete. Few of the participants reported problems in audio streaming, which might be a reason for the low popularity of AT.

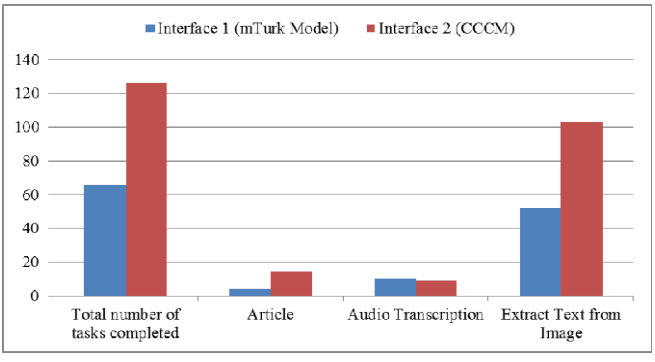


Fig. 7. Number of task completed by users in both I1 and I2

Seven participants out of 16 said they would prefer I2 while 5 participants voted for I1 arguing that once they leave the college campus, the coupons will lose their importance. The remaining 4 participants were neutral because they felt that the amount of work required in both the models is the same. A participant commented that he prefers I2 because it allows him to fulfill his desires and also save money at the same time. Giving an example, he said:

"*As a student, I have to spend my money wisely and cannot afford to eat burger often; but this [coupon] gives me opportunity to do so. If I get money instead, I will think of saving the money and may not fulfill my desires*".

Therefore, his desire for a commodity (burger) motivated him to do the microtasks. Another user mentioned:

"I eat here (college cafeteria) daily, so these coupons could be used daily. Also it feels good to get something for free."

Overall, we observed three types of motivations for participants to work on microtasks:

M1) Desire to earn - participants thought that the platform helps them earn something, either money or commodity.
M2) Desire to save on daily expenses - participants thought that the platform enables them to save on daily expenses by giving a commodity for free.
M3) Desire for commodity – participants thought that the platform helps them satisfy their longing for the commodity.

The decision to work on I1 is only based on motivation M1 while all M1, M2, M3 come into play when a user is exposed to I2. On basis of these results we argue that our model is capable of attracting users' with varied levels of motivation. Moreover we believe that microtasks, when tied to a commodity, can leverage the existing visibility of the commodity, thereby increasing the overall visibility of microtasking platforms.

5 Discussion

CCCM Increases the Visibility and Reach of Microtasking Services. Out of the 71 passengers who completed the survey task in the first study, more than 73% had an education level of grade 12 or less. In contrast, past surveys with mTurk users in India have reported that a large majority of the users at least had a bachelor degree [5, 11]. This result implies that CCCM has the potential to reach those segments of workers which are less likely to be on mTurk.

We also found that the educated and technology savvy crowd workers in our second study had different motivations to perform microtasks, such as *'desire to earn'*, *'desire to save'*, and *'desire for commodity'*. Services like mTurk only cater to the *'desire to earn'*, thus leaving out a section of crowd workers who may have other motivations. CCCM, however, attracts workers with all three motivations and can therefore increase the adoption of microtasking services even among the educated and technology savvy users.

User Profiling and Task Distribution. We observed that the auto-rickshaw drivers offered the mobile phone to only selected passengers. The selection criterion was based on their perceived understanding of passengers' capability to work. The main factors affecting their choice were – passenger's gender, age, language of communication, dressing, and boarding point of the journey. This result is particularly interesting because it shows that the drivers were using their "human intelligence" to profile the workers. Microtasking services such as mTurk also ask for a worker's profile information at sign-up and assign them the tasks accordingly. The drivers accomplished the same using their "human intelligence" and their perceived understanding of a user's profile.

We believe that the intelligence of the human mediators (commodity providers) can be used to recruit and distribute tasks effectively. For example, in the auto-rickshaw scenario, we can group the microtasks into following user categories: 1) College Student, 2) Housewife, 3) Working Professionals, and 4) Others. Before handing over the phone to the passenger (crowd worker), an auto-rickshaw driver can choose one of these categories based on his perceived profile of the passenger. This will ensure that the microtasks given to a worker are relevant for them. For instance, a task related to food recipes can be pushed to a housewife.

Additionally, relevant tasks can be distributed based on the commodity chosen by a worker. For example, a person seeking to purchase an online scientific article is likely to be capable of performing intellectual tasks like article writing. In future, we will explore these task distribution mechanisms based on human-intelligence and commodity choice.

Choice of Tasks and Commodities in CCCM. One of the characteristics of CCCM is that the commodity provider remunerates the workers right after the microtask is completed. This need for instant remuneration, however, leaves little time for task verification. Secondly, when crowd workers are in need of a commodity, they may not have time work on lengthy microtasks.

Therefore, those tasks, which can be (a) done in spurts and (b) do not require a formal verification, are better suited for this model. For example, tasks involving content verification, categorization, surveys and OCR tasks will be preferred over tasks like essay writing.

The choice of commodities in CCCM should be based on the type of microtasks that we want to get done from the workers. For example, microtasks related to surveys and advertisements would prefer to have new crowd workers every day. Such microtasks would benefit from a commodity such as 'auto-rickshaw fare' (study 1) which is more likely to see new workers every day. Similarly, a microtask which requires data from the same set of workers over a period of time would benefit from commodities like 'cafeteria food coupons' (study 2) as the cafeteria is more likely to see the same set of college students every day.

Human Intermediaries as Pervasive Computing Resources. It is clear that the human intermediaries (commodity providers) have a major role to play in the CCCM model. The auto-rickshaw drivers used their human intelligence to profile the passengers and offered the mobile phone only to those passengers who they perceived as qualified enough to work on the microtasks. They also helped the passengers in resolving any queries about the interface or the tasks.

It is important to devise proper incentives for the Commodity Providers to keep them motivated over time. We offered a 20% commission on the value of the microtasks to the auto-rickshaw drivers and found that they were happy with it. Other incentive mechanisms like fixed monthly salaries for Commodity Providers can also be explored.

Payment to Commodity Providers. CCCM reduces the complexity of payment by the microtasking service. Instead of paying all the crowd workers, a microtasking service only has to pay the Commodity Providers. For our study, we paid the commodity providers (auto-rickshaw drivers) in cash. However, in a real-life system the amount can be transferred into their bank accounts.

If the Commodity Providers do not have a bank account, as was the case with the three auto-rickshaw drivers we recruited, they can be given a commodity relevant to them. For example, the auto-rickshaw drivers require fuel on a daily basis, so a microtasking service can give them fuel credits which can be redeemed at different fuel stations. The microtasking service can then do a banking transaction with the fuel station, which is more likely to have a bank account.

Microtask Distribution in Physical Settings. In a real-world deployment of CCCM in physical settings, distribution of microtasks can happen over SMS as demonstrated by Gupta et al. [19]. When a worker approaches the commodity provider (e.g. auto-rickshaw driver), he/she can send a authorization SMS to the microtask repository along with the cellphone number of the worker. In response, the microtasking repository can push the tasks to the worker's phone directly. After the task completion, a notification about the total earning can be sent to both the worker and the commodity provider.

Apart from reducing the burden on the commodity provider, this approach also helps the microtasking repository to gradually create a profile of the workers based on the type of tasks completed by them. This profile information can later be used to push relevant tasks to the workers.

Limitations of the Model. In our model, the crowd workers do the microtasks for a short period of time which makes it hard for them to become task experts. However, in service like mTurk, workers repeatedly do the same microtasks over a period of time, hence developing an expertise in that microtask.

The need for instant remuneration in our model makes it challenging to use those microtasks (for example, summarizing a paragraph of text) which need verification or

quality check from the task provider. The worker would want the commodity instantly and may not want to wait till the verification is complete. We feel that those tasks which can be completed in small spurts are more suitable for this model.

Clearly, our proposed model cannot replace the conventional model of crowdsourcing used by services like mTurk. However, it is an effective way of reaching a much more diverse population of crowd workers who are less likely to join mTurk like services voluntarily.

6 Conclusion and Future Work

We presented a Commodity-Centric Crowdsourcing Model (CCCM) which enables the users to get a commodity of their choice by working on microtasks. Our proposed model address the problems related to low visibility of microtasking services and lack of adequate payment mechanisms in developing regions. We did user evaluation in urban India to understand the applicability of this model in developing regions.

For the first study, we created a prototype application for low-end mobile devices which was used by passengers of auto-rickshaws to work on microtasks. The results show that the passengers were motivated to work on microtasks for a discount on the auto-rickshaw fare. We were also able to reach crowd workers with very different demographics from a typical mTurk user, which proves the ability of CCCM in increasing visibility of microtasking services. Our second study was aimed to collect reaction of a typical mTurk user towards CCCM in comparison to convention crowdsourcing model. Results show that users have different motivations to work on microtasks such as “desire to earn”, “desire to save” and “desire for commodity”. CCCM caters to all these motivations, while conventional crowdsourcing models only appeal to their “desire to earn”. As a result, a higher number of microtasks were done in the study with CCCM as compared to the conventional model.

We discussed the importance of human intermediaries (commodity providers) in user profiling and task distribution, and suggested ways of designing microtasking application leveraging these capabilities of the human intermediaries. We also discussed the limitation of the model which include - (a) it cannot create expert crowd workers, b) the need for instant remuneration limits the kind of tasks that can be used in the model. We do not claim that CCCM will replace the conventional crowdsourcing model. However, we do believe that it can complement the conventional model and help the microtasking services reach a much diverse set of users without worrying about the complexity of paying them with money.

In future, we want to address the issues of user profiling and task distribution and are excited about the idea of using human (Commodity Provider) intelligence for task distribution. We also plan to conduct long term user studies with auto-rickshaw drivers to understand the dynamics of the model over a longer period of time.

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