Social Implications of Crowdsourcing in Rural Scotland

Gokula Vasantha, Jonathan Corney, Nuran Acur, Andrew Lynn, Ananda Jagadeesan, Marisa Smith, Anupam Agrawal

***Abstract*— Various surveys mentioned that the commercial benefits of Internet crowdsourcing are reaped largely by people located in metro areas and smaller cities. The impact of crowdsourcing on the rural population is questionable. The aim of this research is to bridge widening urban and rural divide by providing knowledge-intensive crowdsourcing tasks to rural work force which could provide long term benefits to them as well as improve supporting infrastructure. This paper reports an initial study of the demographic of small samples of twenty two rural homeworkers in Scotland, their motivation to do crowdsourcing work, present main occupation, computer skills, views on rural infrastructure and finally their level of skill in solving three spatial visualization tests. The survey shows that flexible hours of working, extra income, and work life balance are the three important factors emphasized as motivational constructs to do crowdsourcing work. Their skills on solving a spatial visualization test is equivalent to the literature reported results, and also high correlations are identified between these tests. These results suggest that with minimum training the homeworkers could able to solve knowledge-intensive industrial spatial reasoning problems to increase their earning potentials.**

Keywords*— *crowdsourcing; social implication; rural work force

I. Introduction

Surowiecki [1] defines crowdsourcing as the act of taking a task traditionally performed by an employee or contractor, and outsourcing it to an undefined, generally large group of people, in the form of an open call. The success of distributing micro-tasks globally has been widely reported. It has been estimated that in the last decade, over 1 million workers have earned $1-2 billion via crowdsourcing work delivered over the Internet [2]. However the distribution of crowdsourcing benefits across various demographic populations both in developed and developing countries is questionable. A survey of crowd workers on the MTurk crowdsourcing platform reported that more than one-third of them are from India and are typically young and highly educated [3].

Ross et al. [3] conclude that the MTurk worker population has changed over time, shifting from a primarily moderate-income, U.S.-based workforce towards an increasingly international group with a significant population of young, well-educated Indian workers. In that survey, 92% of respondents have a PC and Internet connection in their homes and they are located generally in metro areas and smaller cities. This suggests that the influence of crowdsourcing on rural areas is minimum.

Because most surveys of the demographics of crowd workers are based on the MTurk crowdsourcing platform [4, 5 and 6] (which represent mostly educated urban U.S. and India population), there is a need to understand the demographics of rural homeworkers who could potentially benefit from crowdsourcing tasks in other developed countries. Understanding this rural demographic could help to bridge widening urban and rural gap in an advancing internet based technological economy which requires reliable and up-to-date communication infrastructure. Recently Richard Lochhead, Cabinet Secretary for Scotland's Rural Affairs and Environment reported that slow internet speeds are effecting a depopulation of rural areas in Scotland [7]. He argues that evidence is emerging of broadband-led rural depopulation amid concerns that nearly a fifth of homes in the Scotland Highlands and Islands will remain stuck on slower internet speeds. Previously rural depopulation was thought to be caused by factors such as lack of higher education, affordable housing and/or employment, but now rural internet connectivity is also thought to play a vital role in this relocation. Internet access and slow connectivity speeds can - affect people's ability to connect with the outside world and - access the job market particularly related to crowdsourcing work.

Apart from reaching the rural workers, crowdsourcing has issues in terms of crowd responsiveness, satisfactory results, cost advantage, and importantly security and privacy [2]. Organizations are keen to provide crowdsourcing jobs in the environment where they could get real-time worker responses; excellent results (better than 95% of responses are accurately delivered); should cost less than any traditional approach (but should aligned to national wage standards), and have well-designed facilities for anonymity and data security. In this research we aim to study and use primarily rural workforce to solve crowdsourcing problems in the context of the above issues. We aim to investigate the thesis that large numbers of industrial optimisation tasks involving spatial reasoning can be outsourced to rural workers to provide a sustainable source of skilled employment. Fig. 1 illustrates a sample geometrical packing industrial optimization task. We believe that the

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spatial reasoning tasks associated with many industrial processes and engineering computations have the potential to provide, such a sustained 'value proposition' for both buyers and sellers of the work. This belief is based on the observation that humans, regardless of their educational or social background, are adept at manipulating and reasoning about shapes, a task that computers find extraordinarily difficult to do.

Figure 1. Sample geometrical packing industrial optimization task

As a first step, in this paper we presented demographic of twenty two rural homeworkers in Scotland and assessment of the 3D spatial visualization ability of sixteen rural workers using three tests. The assessment test shows that the spatial manipulation ability of rural workers is equivalent to the benchmark results reported in the literature, and also high correlations are identified between the performance of individual participants in these tests. The assessments demonstrate that the Scotland's homeworkers could able to solve geometrical reasoning industrial tasks without substantial training and frequent exposure to 3D graphics.

The remaining sections of this paper present research questions and methodology followed, demographic of Scotland's homeworkers in comparison to the literature reported results on crowd population, and the assessment results of spatial reasoning skills. The paper ends with a discussion of the results and conclusions with on-going work.

II. Research Questions And Approach Used

To understand social implications of crowdsourcing in rural Scotland and establish spatial manipulation capability of rural homeworkers the following research questions are framed:

- What is the demographic (age, gender, level of education, period of unemployment, present occupation, computer skills) of rural homeworkers available in Scotland?
- Whether homeworkers are satisfied with the rural internet facility?
- What are the motivational factors of homeworkers to do crowdsourcing work?
- What is the 3D spatial visualization ability of rural homeworkers?

Recruiting only rural internet homeworkers was not as simple a task as initially anticipated. However, with the help of a government enterprise for rural development, the researchers were able to advertise for agency "Homeworking testers sought for university research project" via an e-newsletter to participate in this work. The workers were requested to register their interest by creating a login on a website designed especially for this crowdsourcing project. After successful login, the workers see available tasks and choose one at a time to solve those tasks. The workers were rewarded for their time with an Amazon gift voucher for each task successfully completed. From the e-newsletter advertisement, only twenty two rural internet homeworkers had registered in the web portal. Possible reasons for this low number could be due to unimpressive reward system and/or lower circulation of e-newsletter in rural parts of Scotland. For a wider circulation and spread, we are currently advertising through a local rural newspaper to increase the number of home workers participation in our research programme.

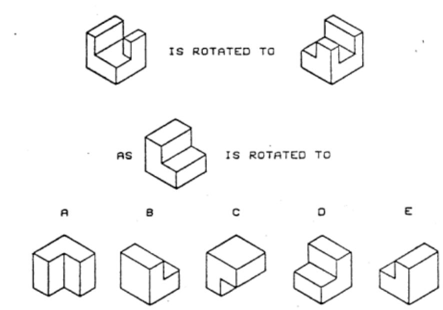

Figure 2. Example question of The Purdue Visualizations of Rotations (ROT) Test [12] – 3D Part A Test

All the participating workers filled in a socio-economic questionnaire and undertook three spatial visualization tests. Since six workers did not complete all the three spatial visualization tests, they are not included in the analysis of spatial visualization ability. In literature, there is no consensus on how to a measure human's spatial reasoning ability [8]. Commonly two major factors define spatial ability: spatial orientation and spatial visualization [9]. The spatial orientation factor has been described "as a measure of the ability to remain unconfused by changes in the orientation of visual stimuli, and therefore it involves only a mental rotation of configuration" [10]. The spatial visualization factor measures "the ability to mentally restructure or manipulate the components of the visual stimulus and involves recognizing, retaining, and recalling configurations when the figure, or parts, of the figure are moved" [11]. We had chosen three spatial visualization tests to assess the spatial ability of the workers. Fig. 2 shows an example of the first test from the Purdue Visualization of Rotations Test (ROT) test [12]. The worker has to study how the object in the top line of the question is rotated, picture in their mind what the object shown in the middle line of the question looks like when rotated in exactly the same manner and select from among the five drawings (A, B, C, D, or E) given in the bottom line of the question the one that looks like the object rotated in the correct position. A time limit of 10 minutes for the 20-item version of this test is strictly enforced.

The second mental rotation test is from the work of Shepard and Metzler [Fig. 3]. The test contains 24 questions. Each question was presented with two images of an object. The second image of the object could be a rotated version of the original object, or it could be different. The workers answer 'Yes' if they believe objects are the same or 'No' if the objects are different. There was no time limit for this test but subjects were asked to answer the questions as quickly as possible.

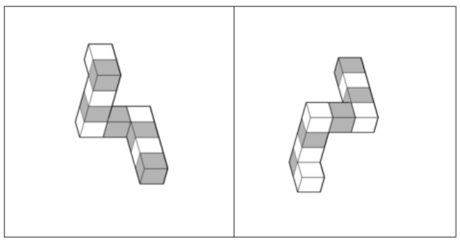

Figure 3. Example question represents Shepard and Metzler Test [13] – 3D Part B Test

The third test used a version of the Mental Rotations Test redrawn by Peters et al. [14]. The original version of the test is framed by Vandenberg and Kuse [15] from Shepard and Metzler [13]. Each worker was given the paper-based 24-item Mental Rotation Test set, and 3 minutes were given for each subset of 12 items, separated by 4 minutes gap. The version of the test used is illustrated in Fig. 4. The subject is presented with four images of objects, two of which will be the same as the target object (shown on the left) but rotated in some way. The worker should identify two images that show rotated versions of the target object. Subjects had to identify both of the correct alternatives, and a score of "1" was given only if both choices were correct. The maximum test score is 24. All the three tests examine three-dimensional spatial visualization ability of homeworkers.

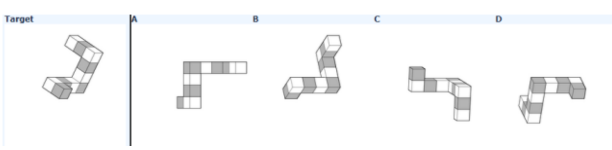

Figure 4. Example question represents Vandenberg and Kuse Test [15] – 3D Part C Test

All the three tests require mental operations on the spatial representation of the object that are more analogous to manipulations of the three-dimensional object being represented than the two dimensional drawings which are actually presented. These three tests are referred to as 3D Part A, 3D Part B and 3D Part C respectively, in the described order. The next section presents the demographic and spatial visualization results of the homeworkers.

III. Results

A. *Demographics of the Scotland's home workers*

Table 1 summarizes the demographics parameters of Scotland's homeworkers. The mean age of homeworker (44.82 years) is substantially higher than the reported MTurk population (31.6 years) [3]. The minimum MTurk population age is 18 [3] whereas minimum age of homeworker is 26. This shows that students did not participate as homeworkers in rural areas.

TABLE I. DEMOGRAPHIC PARAMETERS OF HOMEWORKERS

Demographics parameters	Values
Sample size	22
Age	44.82±8.73 years Minimum: 26; Maximum: 59
Gender	Male: 6; Female: 15
Level of Education	'A' Level or Highers: 2 GCSE, 'O' or Standard Grade: 2 HNC, HND or equivalent: 6 University/college undergraduate degree: 8 Post graduate certification: 3 Postgraduate degree: 1
Period of unemployment	Zero month: 16 Less than one year: 4 Less than two year: 1 Less than three year: 1

There are people above 65+ years in MTurk [3] but limited to 59 years for the homeworker group. In MTurk it has been noted that there is a fairly steady increase in the number of male workers population which is currently more evenly split between the genders [3], whereas female (71.4%) dominates male workers in showing interests to rural homeworking. The Turker population as a whole seems to be highly educated overall 41% of Turkers reported having Bachelor degrees, and 18% report having Graduate degrees [3], whereas the ratio is evenly split between the school pass-outs and university degree holders for the homeworkers. Most of the homeworkers are continuously employed and only few workers having unemployment for up to three years. Currently only one homeworker is unemployed. In contrast around 35% are unemployed for U.S. workers in MTurk crowdsourcing platform. Fig. 5 illustrates the current location of Scotland's homeworkers. It shows the widespread of the rural population is interested in undertaking internet based crowdsourcing jobs. The group strength is more in the rural locations of Stornoway and Thurso of Scotland.

Table II summarizes the current main occupation of homeworkers. It is interesting to note that all the participating homeworkers are from different jobs. In MTurk, about 18% of Turkers sometimes or always rely on MTurk to make basic ends meet [3]. The variety of homeworkers' present jobs suggests that internet based micro-tasks delivered through crowdsourcing platforms could benefit wider spectrum of rural workers and communities.

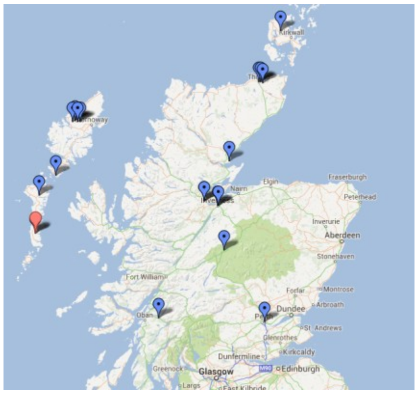

Figure 5. Locations of participated Scotland's rural internet based homeworkers

TABLE II. PRESENT MAIN OCCUPATION OF HOMEWORKERS

Present main occupation
Additional Educational Needs Support Worker; Administrative/Clerical Assistant; Chef in a busy cafe/bistro; Composer & Sound Designer; Customer service; Lowly admin grunt in local hosital; Economic Researcher; Homemaker; Casual freelance web developer; IT Administration; Leather Carver; Night Porter; Promotional gifts supplier; Self Employed - Administrative Support; Self employed shop owner, and management coach; Team leader logistics; Transcribing research interviews; Work on own smallholding; Unemployed.

B. *Motivational factors for crowdsourcing work*

Many studies have assessed the motivation of crowdworkers on different crowdsourcing platforms. Brabham [16] assesses the motivation of submitters on iStockphoto which show that the possibility of earning money is the most dominant motivation, followed by the generated fun. Kaufmann et al. [17] summarizes motivation constructs mentioned by a sample of related literature and proposed a model for worker's motivation in crowdsourcing. They classified intrinsic motivation in terms of enjoyment-based and community based motivation, and extrinsic motivation in terms of immediate payoffs, delayed payoffs, and social motivation. We used these constructs to code the motivation mentioned by the homeworkers. Table III lists the motivation factors and respective frequency mentioned by the homeworkers. It shows that flexible hours of working, extra income, and work life balance are the three important factors emphasized for motivation to do crowdsourcing work. From coding using Kaufmann et al.'s motivation constructs, it is observed that enjoyment-based intrinsic motivation factors predominate in the homeworkers' responses. Some of the factors such as 'to kill time' and 'tasks are fun' observed by Ipeirotis [18] from MTurk workers are not mentioned by the homeworkers. This difference between MTurkers and homeworkers could be due to the high mean age of homeworker than MTurk population. The homeworkers seem to be more motivated by their personal needs than community-based or social motivation. On average, Turkers earn just under $2.00/hour [3] which is not a compelling proposition for the homeworkers who would like to earn significant extra income in their leisure hours.

C. *Computer and Internet Skills*

Table IV summarizes the ratings of computer and internet skills provided by the homeworkers. Except for a few people with only "fair" rating for computer vocabulary and software usage skills, the population is generally "good" at the needed skills required for internet homeworkers. Therefore no training is required to enhance computer and internet skills before giving real-time industrial tasks.

Table V summarizes the homeworkers' satisfaction ratings with the rural infrastructure for internet connection and road connectively. Most of the people expressed satisfaction with their connectivity in undertaking crowdsourcing tasks. However, a few disagree with that their infrastructure facilities are adequate. This could be in terms of internet speed and bandwidth capacity in comparison to urban areas. An in-depth study is required to understand their issues based on widely dispersed rural locations.

TABLE III. MOTIVATIONAL FACTORS FOR CROWDSOCURCING WORK

Motivation factors	Frequency	Motivation constructs
Flexible hours of working	6	Enjoyment-based
Anything to boost income (in a safe environment)[a]	5	Immediate Payoffs
Being able to set own work load and hours; work life balance (childcare)	5	Enjoyment-based
Use spare time productively	2	Enjoyment-based
Convenience	2	Enjoyment-based
Skill and experience suitable	2	Enjoyment-based
Lack of employment opportunities	2	Community based
Work without having to travel (no travel costs)	2	Enjoyment-based
Enhance skills and working on projects which will build my portfolio and make me more employable	1	Delayed Payoffs
Can live in a rural area and support myself	1	Enjoyment-based
Challenging task	1	Enjoyment-based
Own initiative	1	Enjoyment-based
To keep active	1	Enjoyment-based
Retreat from all the stress from the current job	1	Enjoyment-based
Poorly paid in the day job	1	Immediate Payoffs
Enthusiasm	1	Enjoyment-based

TABLE IV. COMPUTER AND INTERNET SKILLS OF HOMEWORKERS

	Very Poor	Poor	Fair	Good	Excellent
Basic Computer Skills				6	16
Computer vocabulary			2	9	11
Software usage skills			3	4	15
E-mail communication				3	19
Internet skills				4	18

TABLE V. RATINGS OF INFRASTRUCTURE TO SUPPORT CROWDSOURCING WORK

	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
Fulfilment with Communication/Internet connection	-	1	3	5	12
Road connectivity	-	2	2	6	11

D. Monthly income

The analysis of the monthly income of the homeworkers reveals that the 25th percentile to 75th percentile of the population varies from 500 to 1500 UK pounds. The statistical data shows individual taxpayers median income before tax in 2009-10 is £19,600 in the UK [19]. The average homeworker's monthly income seems to be less than the reported individual income.

E. Benefits received from the government

Table VI summarizes the government benefits received by the homeworkers and the number of beneficiaries. The child benefit predominates in the category followed by tax credits and job seekers allowances. Also few of them did not receive any benefit from the government. Not surprisingly many homeworkers who received government benefits also had the lower monthly income level from their present occupation.

TABLE VI. BENEFITS RECEIVED FROM THE GOVERNMENT

Benefits	Number of beneficiaries
Maternity allowance	1
Disabled Living Allowance	1
Mobility Allowance	1
Unemployment - job seekers	4
Working tax / tax credits	5
None received	6
Child benefit	10

F. Household able to make ends meet

The homeworkers were asked to provide a rating on a five-point scale for a question whether their household is able to make "ends meet" given their total monthly income. Table VII tabulates the results for this question. Again it suggests that most of the homeworkers are having great, or some, difficulty in covering all their domestic expenses.

G. Geometrical reasoning skills of homeworkers

The first step to crowdsourcing large numbers of industrial optimisation tasks involving spatial reasoning to rural workers to provide a sustainable source of skilled employment is to assess their skills based on normally used spatial visualization tests. The three tests used measures different spatial visualization skills along with challenging time variation set for each test. Table VIII presents the results of these three tests and Fig. 6 illustrates the spread of results. Out of 22 participated homeworkers, only 16 homeworkers had completely finished all the three tests. The results show that the homeworkers performed well in the 3D Part B test and scored poorly in the 3D Part C test. The reason for this variation could be: 3D Part B is just a comparison of two objects to identify whether they are similar or dissimilar with no time limit; whereas the 3D Part C test requires participants need to identify two correct objects out of four options with a time limit of 3 minutes. The results show that the homeworkers understood the spatial visualization problem and were able to answer the questions correctly, but they may lack skills to solve challenging spatial visualization problems in a quicker time.

TABLE VII. RATINGS FOR HOUSEHOLD ABLE TO MAKE ENDS MEET

With great difficulty	With some difficulty	Neutral	Fairly easily	Very easily
3	6	7	1	1

TABLE VIII. HOMEWORKERS' CORRECT SCORES IN 3D ROTATIONAL TESTS

N=16	Maximum score	Mean	Standard Deviation	Minimum	Maximum
3D Part A	20	11.25	4.84	1	17
3D Part B	24	17.25	3.44	11	23
3D Part C	24	6.06	3.77	1	14

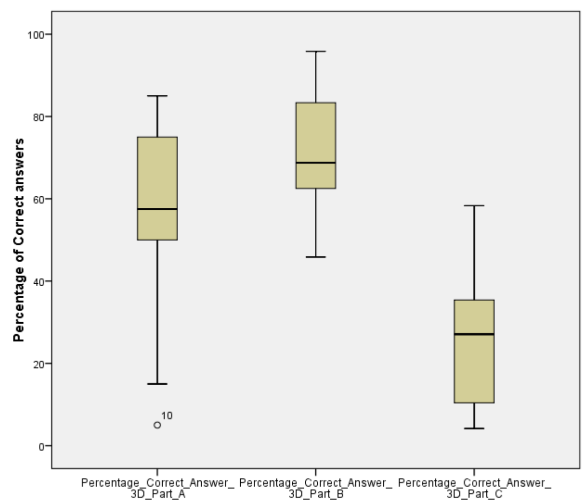

Figure 6. Comparison of percentages of correct answers in three 3D tests

Table IX lists the results of 3D Part A assessments reported literature. Comparing Tables VIII and IX reveals that the homeworker's skills are almost equivalent to the reported results. Especially compared to the mean female score, indeed the homeworker's mean score is slightly better. This comparison supports the initial assertion that crowdsourcing spatial reasoning tasks to rural homeworkers could produce the similar results to those obtained by the urban population. With minimal training, the aged rural homeworkers could also be able to solve industrial tasks quickly and competently. However, the motivational constructs mentioned by them need to be considered while developing real-time industrial work flow between industries and homeworkers.

TABLE IX. LITERATURE REPORTED RESULTS OF CORRECT SCORES IN 3D PART A TEST

Reference	Samples	Mean	Standard Deviation
Brownlow et al. [20]	129 Liberal-arts college students	Male: 10.31 Female:10.63	Male: 4.54 Female:3.99
Poulin et al. [21]	218 Undergraduate students	Male:13.8 Female:10.8	Male:0.44 Female:0.35
Dean [22]	114 University students	Male: 12.83 Female:9.82	Male: 3.63 Female:4.00

TABLE X. KENDALL'S TAU_B NON-PARAMETRIC CORRELATION LITERATURE REPORTED RESULTS OF CORRECT SCORES IN 3D PART A TEST

	3D Part A	3D Part B	3D Part C
3D Part C	0.682 *($p<0.01$)*	0.384 *($p<0.05$)*	1
Significance (two tailed)	.000	0.045	-

Table X presents Kendall's tau-b non-parametric correlation between the three spatial visualization tests. The 3D Part C test is significantly correlated with other two tests. These results signify that the homeworkers' abilities are consistently measured across the different forms of the spatial visualization tasks (i.e. B and C). However no significant correlation is identified between the 3D Part A and Part B tests.

IV. Conclusion and ongoing work

Internet connectivity is a key issue in rural depopulation. Providing industrial crowdsourcing tasks to rural work force could provide long term benefits and improve supporting infrastructure. In this on-going research project, the initial study with a small sample of rural homeworkers represents the demographic of rural homeworkers as aged population, dominated by female workers, low unemployment rates, dispersed rural locations, and with a variety of main occupations. The key issue observed is their low monthly income compared to average national individual income. This finding is reiterated in other results, such as many occurrences of receiving government benefits and their difficulty with domestic budgets. The motivation of homeworkers predominantly lies in intrinsic constructs such as flexible hours of working, extra income, and work life balance. These constructs pose challenges to develop viable industrial crowdsourcing tasks because industries perhaps require nearly real-time worker response and results. However the initial spatial visualization skills assessment demonstrates that other industrial needs such as delivering better than 95% of results accurately, cost advantage, and in a private and secured crowdsourcing environment could be achieved with relative ease by rural workers. These results suggest that with minimum training the homeworkers could able to solve potential industrial spatial reasoning problems to increase their earning potentials. The on-going work involves increasing participation of rural homeworkers in our research programme, investigate on their interest to solve spatial reasoning tasks, issues related to internet connectivity, and identify effective methods of training to enable the solution of industrial tasks quickly.

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