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A special issue devoted to
Harnessing the Power of Crowd for Sustainable Future

Guest Editors
Mohd Hazli Mohamed Zabil, Badariah Solemon & Suhaimi Ab Rahman

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About the Journal

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Pertanika Journal of Science & Technology (JST) is the official journal of Universiti Putra Malaysia published by UPM Press. It is an open-access online scientific journal which is free of charge. It publishes the scientific outputs. It neither accepts nor commissions third party content.

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The *Introduction* explains the scope and objective of the study in the light of current knowledge on the subject; the *Materials and Methods* describes how the study was conducted; the *Results* section reports what was found in the study; and the *Discussion* section explains meaning and significance of the results and provides suggestions for future directions of research. The manuscript must be prepared according to the Journal's **INSTRUCTIONS TO AUTHORS**.

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Notification of the editorial decision is usually provided within ten to fourteen weeks from the receipt of manuscript. Publication of solicited manuscripts is not guaranteed. In most cases, manuscripts are accepted conditionally, pending an author's revision of the material.

As articles are double-blind reviewed, material that might identify authorship of the paper should be placed only on page 2 as described in the first-4 page format in Pertanika's **INSTRUCTIONS TO AUTHORS** given at the back of this journal.

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In the peer-review process, three referees independently evaluate the scientific quality of the submitted manuscripts.

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2. The chief executive editor sends the article-identifying information having been removed, to three reviewers. Typically, one of these is from the Journal's editorial board. Others are specialists in the subject matter represented by the article. The chief executive editor asks them to complete the review in three weeks.

   Comments to authors are about the appropriateness and adequacy of the theoretical or conceptual framework, literature review, method, results and discussion, and conclusions. Reviewers often include suggestions for strengthening of the manuscript. Comments to the editor are in the nature of the significance of the work and its potential contribution to the literature.

3. The chief executive editor, in consultation with the editor-in-chief, examines the reviews and decides whether to reject the manuscript, invite the author(s) to revise and resubmit the manuscript, or seek additional reviews. Final acceptance or rejection rests with the Edito-in-Chief, who reserves the right to refuse any material for publication. In rare instances, the manuscript is accepted with almost no revision. Almost without exception, reviewers' comments (to the author) are forwarded to the author. If a revision is indicated, the editor provides guidelines for attending to the reviewers' suggestions and perhaps additional advice about revising the manuscript.

4. The authors decide whether and how to address the reviewers' comments and criticisms and the editor's concerns. The authors return a revised version of the paper to the chief executive editor along with specific information describing how they have answered' the concerns of the reviewers and the editor, usually in a tabular form. The author(s) may also submit a rebuttal if there is a need especially when the author disagrees with certain comments provided by reviewer(s).

5. The chief executive editor sends the revised paper out for re-review. Typically, at least one of the original reviewers will be asked to examine the article.

6. When the reviewers have completed their work, the chief executive editor in consultation with the editorial board and the editor-in-chief examine their comments and decide whether the paper is ready to be published, needs another round of revisions, or should be rejected.

7. If the decision is to accept, an acceptance letter is sent to all the author(s), the paper is sent to the Press. The article should appear in print in approximately three months.

   The Publisher ensures that the paper adheres to the correct style (in-text citations, the reference list, and tables are typical areas of concern, clarity, and grammar). The authors are asked to respond to any minor queries by the Publisher. Following these corrections, page proofs are mailed to the corresponding authors for their final approval. At this point, **only essential changes are accepted**. Finally, the article appears in the pages of the Journal and is posted on-line.

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Mohd Hazli Mohamed Zabil, Badariah Solemon
& Suhaimi Ab Rahman

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ABSTRACTING/INDEXING

Pertanika is now over 35 years old; this accumulated knowledge has resulted the journals being indexed in SCOPUS (Elsevier), Thomson (ISI) Web of Knowledge [BIOSIS & CAB Abstracts], EBSCO, DOAJ, Google Scholar, AGRICOLA, ISC, Citefactor, Rubriq and MyAIS. JST is also indexed in ERA.

Preface

We are very pleased to present this special issue of the Pertanika Journal of Science and Technology (JST). This issue is a compilation of selected papers that were presented at the First International Conference on Collective Human Intelligence and Crowdsourcing Applications (ICHICA 2016), held on the 5th & 6th October 2016 in Universiti Tenaga Nasional. The ICHICA 2016 was organized in view of the unprecedented development in the crowdsourcing research that has seen the proliferation of many types of crowdsourcing application. Such development is expected to open up more research opportunities that can be ventured by both, academia and industry alike.

The ICHICA 2016 was the first ever academic conference on collaborative human intelligence and crowdsourcing held in Malaysia, which certainly marks an entry in the history of crowdsourcing research collaboration in the country. In line with the theme "Harnessing the Power of Crowd for Sustainable Future", the ICHICA 2016 topics include but not limited to: Crowd Intelligence, Crowdsourcing Applications/ Platforms, Crowdsourcing Design, Crowdsourcing Policy, Frameworks and Business model, Crowdsourcing for Disaster Management, Crowdsourcing for Low-Income Earners, Crowdsourcing for Usability, Crowdsourcing Infrastructure, Crowdsourcing Knowledge Representation, Crowdsourcing in Software Engineering, Engagement and Activation, Innovative Computing, Intellectual Property Issues in Crowdsourcing, Non-profit Crowdsourcing, Quality Assurance in Crowdsourcing, Security and Privacy Issues in Crowdsourcing, Sustainable Crowdsourcing, and Crowdsourcing Metrics and Evaluation.

We would like to thank the contributors as well as reviewers for their commitment and patience, which made this JST ICHICA 2016 a successful endevour. It is hoped this publication would be an encouragement for researchers from around the world to be more active in publishing their research papers.

Our deepest gratitude belongs to Dr. Nayan Kanwal, Chief Executive Editor, Journal Division, as well as the team of Editorial Office, Pertanika, Universiti Putra Malaysia with whom we have had a chance to interact and learn of some of the processes involved in the publication of this Pertanika Special Issue.

Guest Editors

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Mohd Hazli Mohamed Zabil *(Dr.)*
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Automated Update of Crowdsourced Data in Participatory Sensing: An Application for Crowdsourced Price Information

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ABSTRACT

Widespread use of mobile devices has resulted in the creation of large amounts of data. An example of such data is the one obtained from the public (crowd) through open calls, known as crowdsourced data. More often than not, the collected data are later used for other purposes such as making predictions. Thus, it is important for crowdsourced data to be recent and accurate, and this means that frequent updating is necessary. One of the challenges in using crowdsourced data is the unpredictable incoming data rate. Therefore, manually updating the data at predetermined intervals is not practical. In this paper, the construction of an algorithm that automatically updates crowdsourced data based on the rate of incoming data is presented. The objective is to ensure that up-to-date and correct crowdsourced data are stored in the database at any point in time so that the information available is updated and accurate; hence, it is reliable. The algorithm was evaluated using a prototype development of a local price-watch information application, CrowdGrocr, in which the algorithm was embedded. The results showed that the algorithm was able to ensure up-to-date information with 94.9% accuracy.

Keywords: Automated algorithm, big data, crowdsourcing application, crowdsourced data, data deletion, data management, price information

INTRODUCTION

Crowdsourcing is "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" (Howe, 2006). Today, 10 years after the term was coined, a large number of crowdsourcing initiatives exist in various forms and for various purposes. Crowdsourcing is used in news making (Alam & Campbell, 2012; Väätäjä,

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Vainio, & Sirkkunen, 2012), disaster relief management (Poblet, García-Cuesta, & Casanovas, 2014; Zook, Graham, Shelton, & Gorman, 2010), the creation of new products (Djelassi & Decoopman, 2013; Füller, Hutter, & Faullant, 2011) and fund raising (Althoff & Leskovec, 2015; Brabham, 2010), to name a few uses. Crowdsourcing is also used in information sharing (Aris & Din, 2014; Olleros, 2008). A more complete list of crowdsourcing examples can be found in the work of Aris and Din (2016, March), who list a total of 60 crowdsourcing initiatives. Leveraging on the widespread use of mobile devices, crowdsourcing initiatives are shifting to mobile platforms with the expectation of reaching larger crowds, leading to the birth of mobile crowdsourcing. Mobile crowdsourcing is a form of crowdsourcing that advertises and submits tasks through a mobile crowdsourcing application (MCA) installed in mobile devices (Väätäjä et al., 2012). Mobile crowdsourcing has led to two types of crowd involvement in crowdsourcing: participatory sensing and opportunistic sensing (Chatzimilioudis, Konstantinidis, Laoudias, & Zeinalipour-Yazti, 2012). In participatory sensing involvement, crowds participate through conscious contribution of data to the crowdsourcing initiative. The data are thus said to be manually generated by the crowd (Chatzimilioudis et al., 2012). Examples of MCAs that employ participatory sensing are Kpark (Davami & Sukthankar, 2015), Hazard Reporting (Chatfield & Brajawidagda, 2014), IndoorCrowd (Chen, Li, & Ren, 2014) and FloodPatrol (Yang et al., 2014). In these applications, information such as parking space availability and incidents of disastrous event comes from the users based on the knowledge obtained by observing things that are happening around them. The information is submitted using the applications through manual keying in of the information. On the other hand, in opportunistic sensing involvement, the crowd contribute data rather unconsciously because the data automatically 'sensed' by the sensors attached to the crowd's mobile devices (Chatzimilioudis et al., 2012). This is made possible by the technology available in most smartphones today that embed various sensors such as the global positioning system (GPS), gyroscope and accelerometer. Examples of MCAs that employ opportunistic sensing are PotHole (Simon, 2014), OpenSignal (OpenSignal, 2015), WeatherSignal ("About WeatherSignal," 2016) and VTrack (Thiagarajan et al., 2009). In these MCAs, data such as wireless signal strength and current temperature at a particular location are obtained through the sensors embedded in the mobile devices. Participatory and opportunistic sensing do not necessarily have to exist in mutual exclusivity in MCAs. Waze (2016), a widely known MCA, is an example of an MCA that employs both participatory and opportunistic sensing. Participatory sensing data are obtained from the response entered by the crowd, while opportunistic sensing data are obtained from the mobile device's accelerometer, which provides the speed of a moving car, and GPS, which provides its location. Waze thus automatically generates the traffic map based on GPS sensors and manual input from the crowd.

The use of mobile crowdsourcing in data collection poses new challenges due to the following nature of crowdsourced data that come mostly from volunteers.

1. Data that arrive at no specific time and are often at irregular intervals make it difficult to manually predict the frequency of incoming data.
2. Data that arrive in large volumes (big data) may be duplicated data, and therefore, redundant.

3. Data contributed by people from all walks of society, who come from different backgrounds and expertise, could mean that inaccurate, wrong or tampered data are possible.

In order for the crowdsourced data to remain updated, obsolete data have to be timely replaced with new data, or at least removed from the database even when without replacement. This is to ensure that only valid data are stored at any given time. Furthermore, due to the large volume of contributions to crowdsourced data, duplicate data are unavoidable. A selection or filtering mechanism is thus needed to decide on the data that should be captured and stored in the database. This is to ensure that the duplicate data do not overwhelm the database unnecessarily. Finally, to be useful and reliable, the up-to-date data captured from users have to be accurate too. This is one of the main challenges in crowdsourced data or big data (Agrawal, Das, & El Abbadi, 2011) i.e. inaccurate, wrong or tampered data. A mechanism that is able to detect the presence of invalid data is also needed.

To address the above challenges, an algorithm for automated update of these data through removal of obsolete and duplicate data is proposed. The objective is to ensure that at any particular point in time, application of the algorithm is able to ensure that only up-to-date and valid information is stored in the database. The detection and removal of duplicate and obsolete data have to be done automatically due to the nature of crowdsourced data, which come at an irregular and unpredictable rate, as mentioned in Point 1 above. The proposed algorithm is applicable to crowdsourced data with the following characteristics:

- Dynamic in nature, which means that frequent changes over a short period of time are expected; and
- Accuracy is important and slight deviation from accurate data may give a significant effect to render the information useless.

In this paper, the algorithm is presented and described. The algorithm focusses on participatory sensed data because in our opinion, this type of data is more prone to error introduced by the crowd. Furthermore, the scope of the algorithm is on data that are comparable, such as numerical data, which have exact accurate values rather than subjective data, which have a range of accurate values. For the purpose of demonstration and evaluation, the algorithm was implemented in a mobile crowdsourcing application, CrowdGrocr, which crowdsourced price information from users. The price information stored in the server (database) was compared with the actual price displayed at a number of selected stores under study to determine its accuracy.

Algorithm Construction

In this section, the construction of automated data removal of duplicate and obsolete dynamic crowdsourced data is explained. The algorithm comprises two parts. The first part is the detection and removal of duplicate data and the second is the detection and removal of obsolete data.

Removal of Duplicate Data

The first part of the algorithm targets two objectives: to prevent the large amount of data from swamping the database and to identify the correct data from the plethora of data entered. Both objectives are achieved by means of a series of simple steps embedded into the algorithm that determine the correct data by observing their frequency of occurrence. The assumption is that the higher the frequency of occurrence of the same data, the higher the likelihood that the data are correct. A minimum frequency, mf, is set and if the frequency of a series of consecutive duplicate data meets the mf value set, that data are deemed correct and hence, will be stored in the database. The first part of the algorithm is shown in Figure 1. As can be seen in Figure 1, the steps in the algorithm are triggered by data entry from the users i.e. the algorithm is automated. The algorithm begins in an idle state in which it is ready to receive data entered by the users. Each datum entered will increase the first counter, count1, which is initially set to zero, by one. The purpose of count1 is to identify if the data entered is the first time this data has been received. If it is, the data will be stored in the database. The reason for this is to ensure that as many data as possible are populated in the database. Correctness of data is dealt with later as more data are entered by the users. Each datum entered is also tagged according to the time entered, a *tstamp*. When a datum is selected to be stored in the database, the time entered, ts, which is taken from the *tstamp,* will also be stored.

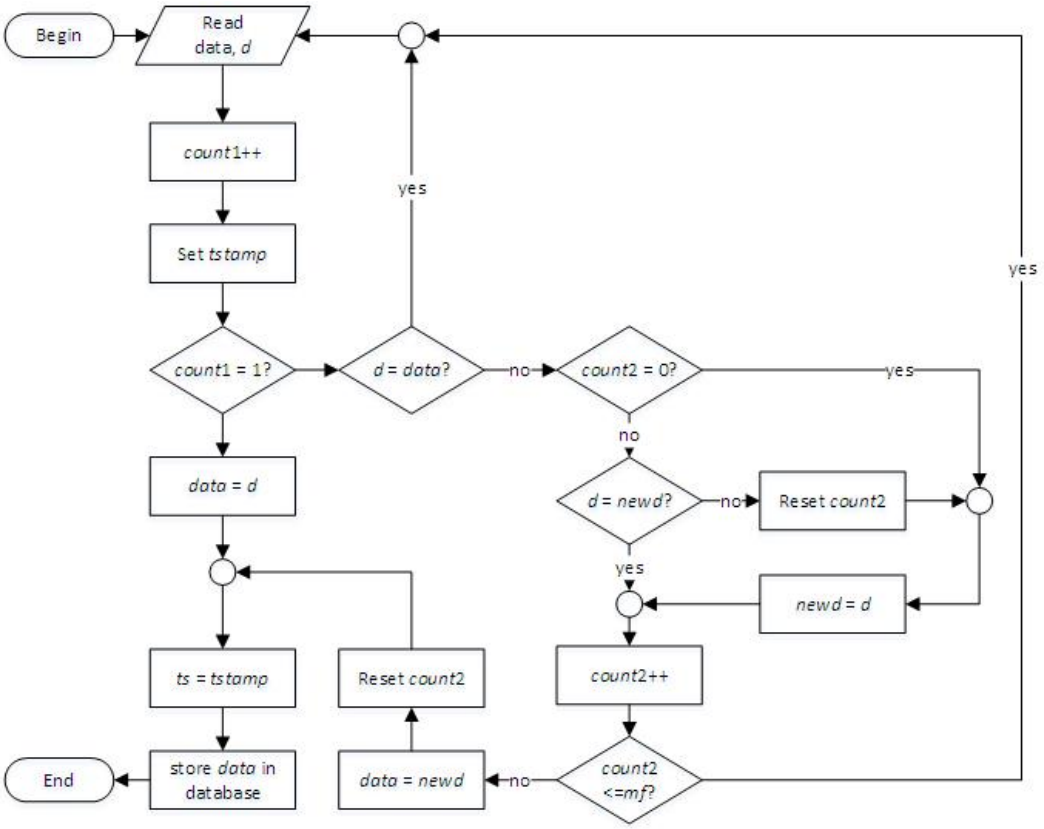


Figure 1. Automated detection and removal of duplicate data

If it is not the first time the data has been entered, the data will be compared with previously stored data in the database. If it matches previously stored data, meaning the same data have been received, the data will be discarded. If the data received are different from the value of the stored data, the difference is read as a potential change and the value of the second counter, count2, will be checked. If count2 is zero, the data will be temporarily stored as new data, newd, and the count2 value is increased by one point. If the count2 value is not zero, the data will be compared with the current value of newd. If they are the same, the count2 value will be increased further. If they are not, the count2 value is reset and the data will become the new newd value. After each increment, the count2 value is compared with the minimum frequency, mf, value set. If the mf value is reached, the data will be stored in the database together with its time stamp, ts, replacing the existing data. The count2 value will be subsequently reset as a result.

Removal of Obsolete Data

Dynamic crowdsourced data are subject to frequent changes, which means that the validity period of such data is comparatively short. Therefore, the stored data need to be refreshed from time to time to ensure that stored data are always up-to-date. Expired data need to be removed from the database, with or without replacement. For this reason, the second part of the algorithm focusses on detecting and removing expired data. Unlike the first part of the algorithm that is triggered by crowd input, the second part of the algorithm is designed to run continuously and repetitively at fixed time intervals, min, as shown in Figure 2. To begin with, the checking time, lastcheck, is set to current time, current. The algorithm will then run continuously, comparing the lastcheck with the current time. Each time the difference is larger than the predetermined time interval, min, all data in the database will be checked. The time stamp, ts, of each datum will be compared with the current time and if the difference (lapse) is larger than the defined duration, the data will be deleted from the database together with its associated time stamp. Subsequently, the count1 value will be reset to zero to indicate that the data are no longer available in the database and hence, the database is ready to accept new data as defined in the first part of the algorithm. At the end of the execution of the second part of the algorithm, the current time will be recorded as the new lastcheck. The next iteration of this part of the algorithm will begin when the difference between current time and lastcheck exceeds min and so on.

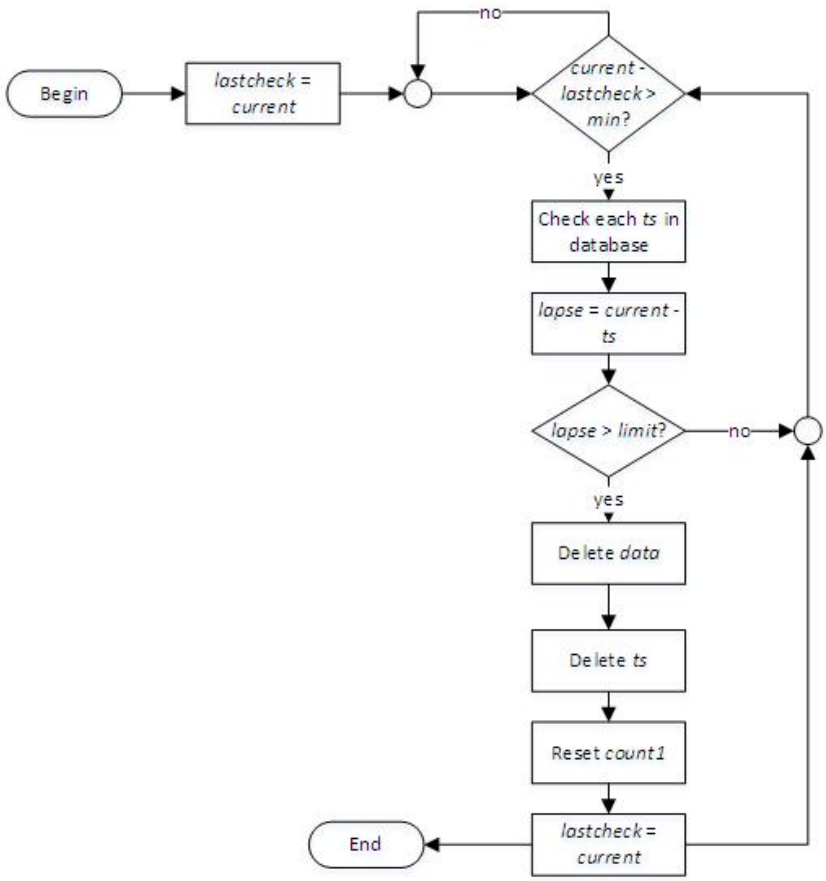


Figure 2. Automated detection and removal of obsolete data

Evaluation of Algorithm

For the purpose of evaluating the algorithm, a prototype of a local price-watch information application was developed, in which the algorithm was embedded. The prototype served as a means for users to enter information on item prices at store they visited. Therefore, the crowdsourced data in this case were the item prices at local supermarkets. Price information fits as a criterion of the crowdsourced data to be handled by this algorithm because price information changes from time to time i.e. it is dynamic, and each change matters. Changes in item prices can significantly affect household expenditure.

Instantiating the Algorithm

In order to apply the algorithm designed, three constants used in the algorithm need to be determined. These constants are mf, min and limit. To identify appropriate values for these constants in the context of price information, a series of surveys were conducted among a number of selected stores with the aim of obtaining information on the movement of item prices. Five stores were included in the survey; for confidential and privacy reasons, they

were called Store A, Store G, Store M, Store T and Store N. Brief profiles of these stores are shown in Table 1.

Table 1
Profiles of the selected stores

Store ID	Distance from Research Location (km)
Store M	11
Store N	11.4
Store G	13
Store A	9.4
Store T	5.1

The surveys were conducted on a weekly basis between 4 August 2015 and 26 August 2015. Initially, 20 grocery items were included in the survey; this was later increased to 26 due to inconsistent availability of some selected items at certain stores. At the end of the surveys, the following observations were made with regard to the movement of item prices in the market.

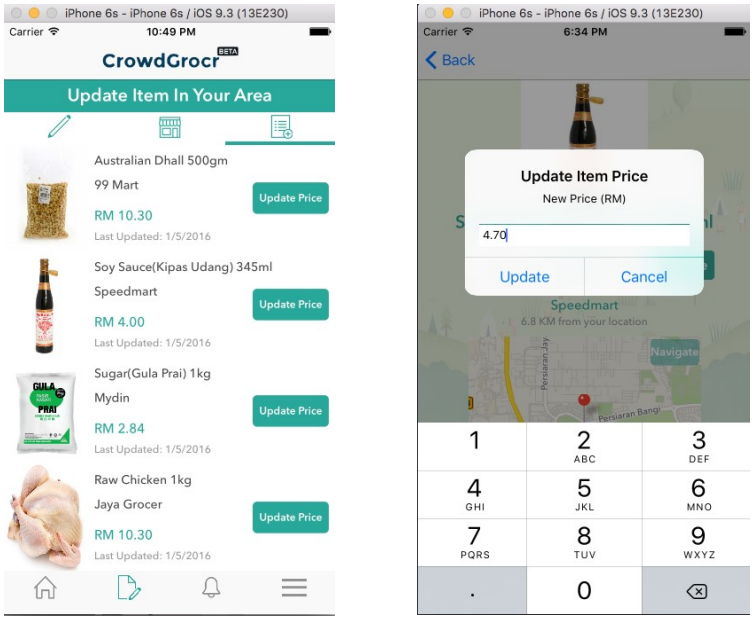
- Item price that changed only once a month: These items experienced price difference only once throughout the four weeks of the survey. Ten items in three stores were found to belong to this category.
- Item price that changed a few times during the month: This category of items experienced price changes at least two or three times during the four weeks of the survey. Five items at two stores belonged to this category.
- Price change during festive seasons or particular celebrations: At least two items were found to belong to this category, and they were detected based on a significantly large price drop.

Based on the observations above, the limit value, which is used in the second part of the algorithm, was set to one week because there was evidence of price changes after a week. This highlights that the second part of the algorithm that runs continuously compares the current time and the ts value of each price stored in the database. When the difference comes after more than a week, the price information will be regarded as obsolete and hence, removed from the database. Checking frequency, min, is determined by a number of factors such as rate of incoming data and processor capacity. We recommend that the frequency be based on the optimum trade-off value between processor capacity and the minimum period of data reaching obsolescence; this may require further research to formulate. For the purpose of demonstrating the implementation of the algorithm, we set the min value to five minutes; this means that the second part of the algorithm will continuously check each price in the database every five minutes. Finally, the mf value needs to be set. The mf value determines the number of occurrences of repeated price information entered that need to be temporarily recorded before the price value is accepted and stored in the database. We recommend this value to be determined based on the incoming crowdsourced data rate, which might be different depending

on the types of data. In our experiment, the mf value was set at three for the reason explained in the next subsection.

Prototype Development

For the purpose of the field experiment, a local price-watch information application, CrowdGrocr, which is an MCA, was developed. CrowdGrocr is an application that collects information on household item prices from its users. It provides functions that enable users i.e. the crowd to share information on prices of items at the local stores that they visit. If an item was previously recorded in the database, users need to only update its price. Otherwise, users may enter information about the item to record it as a new item. The prototype was developed based on the local price-watch information solicitation and sharing model in Aris and Md Din (2014). Adhesive mobile crowdsourcing application features described in Aris (2015, January) i.e. geo-tagging and automatic update of prices were also implemented in the prototype; the latter resulted in the construction of the algorithm discussed in this paper. Price information collected from the crowd through CrowdGrocr is stored in the database in such a way that it can be used to compare prices of items offered by nearby stores as shown in Figure 3(a). Thus, CrowdGrocr enables users to conveniently compare prices of items offered by nearby stores without having to leave the comfort of their homes. As justified in Aris (2015), crowdsourcing price information from users helps to overcome the problem of out-of-date price information faced by similar applications that use conventional data collection methods, such as those that use a system administrator or appointed agents (Syafiq, 2016).



(a) (b)

Figure 3. (a) Price comparison interface, CrowdGrocr, and (b) Price record interface, CrowdGrocr

Field Experiment

Field experimentation to evaluate the algorithm was conducted over two weeks between 18 January 2016 and 31 January, 2016. For the purpose of evaluation, the CrowdGrocr prototype was installed in participants' mobile devices. Open recruitment of participants was made through online social media advertisement. For this evaluation, there were no specific requirements asked of the users who could participate because price information is related to shopping and shopping is done by people of all ages. As long as they had the means to access the prototype and they were in the vicinity of the stores under study, they could participate. A total of 20 participants were recruited through online advertisement. The participants were evenly distributed among the five selected stores in Table 1. Each of them was responsible for visiting the assigned store during the two-week period of evaluation and recording the prices of 10 items in the given list in CrowdGrocr during the visit. The 10 items were selected based on the previous surveys conducted, from which it was found that some items were available in all the selected stores. Figure 3(b) shows the interface of the prototype. Apart from being asked to use CrowdGrocr, the participants were also asked to fill in the price information on paper forms as backup. To determine the accuracy of the algorithm i.e. its ability to ensure that up-to-date and correct price information was stored in the database at any point in time, manual checking of the prices by item was also performed by one of the researchers. The five stores were visited weekly during the two-week evaluation period and the prices of the same 10 items were recorded, together with the date and time of the visit. As the price of each item was manually checked, the researcher ran CrowdGrocr to check the price of the same item captured at that particular time.

RESULTS AND DISCUSSIONS

At the end of the two-week evaluation period, only 18 participants managed to submit the price information as required. A total of 98 manually checked prices of 10 selected items at the five stores mentioned above were collected, short of two prices because one item was not available at one of the stores. This represented 49 prices checked each week. Table 2 shows the comparison results of the 10 items in the first week of evaluation. Results of the comparison made between the manually checked prices and the corresponding prices shown by the CrowdGrocr application showed that 44 out of 49 prices were the same i.e. 89.8% accuracy was attained in the first week of the evaluation period. The results for the second week of the evaluation period showed improved accuracy, with 47 out of the 49 manually-checked prices being the same as the ones in CrowdGrocr, accounting for 95.9% accuracy. However, the table providing the evaluation results for the second week of evaluation is not shown here due to lack of space. Average accuracy was 94.9%.

Table 2
Comparison between price computed by the algorithm and the actual price displayed at supermarkets in the first week of evaluation

Item (Brand)	Store ID	Date & time	Actual Price (RM)	Computed Price (RM)
Chicken eggs Omega 3 (NUTRIPLUS) (10 pcs)	Store A	2016-01-23 16:40	5.45	5.45
	Store G	2016-01-23 17:17	5.39	5.39
	Store M	2016-01-23 14:36	5.29	5.29
	Store T	2016-01-23 15:40	5.19	5.19
	Store N	2016-01-23 18:21	4.60	4.60
Super special local rice (JATI) (10 kg)	Store A	2016-01-23 16:56	25.90	25.90
	Store G	2016-01-23 17:17	25.99	25.99
	Store M	2016-01-23 14:36	25.95	25.95
	Store T	2016-01-23 15:40	25.99	25.99
	Store N	2016-01-23 18:21	-	-
Body Wash Refill Pack (LIFEBUOY) (900 ml)	Store A	2016-01-23 16:37	14.30	10.88
	Store G	2016-01-23 17:14	14.14	14.14
	Store M	2016-01-23 14:33	13.37	13.37
	Store T	2016-01-23 15:38	10.88	10.88
	Store N	2016-01-23 18:18	11.30	11.30
Kicap manis (KIPAS UDANG) (345 ml)	Store A	2016-01-23 16:43	5.95	5.95
	Store G	2016-01-23 17:19	6.03	6.03
	Store M	2016-01-23 14:40	4.95	4.95
	Store T	2016-01-23 15:41	5.99	5.38
	Store N	2016-01-23 18:25	5.25	5.25
Milo Refill Pack (NESTLE) (2 kg)	Store A	2016-01-24 14:07	38.90	38.90
	Store G	2016-01-24 14:03	36.89	32.98
	Store M	2016-01-24 14:00	33.90	33.90
	Store T	2016-01-24 14:11	35.99	30.98
	Store N	2016-01-24 13:58	35.50	35.50
Crackers (JACOBS) (800 g)	Store A	2016-01-23 16:35	13.90	13.90
	Store G	2016-01-23 17:12	12.99	12.99
	Store M	2016-01-23 14:32	12.86	12.86
	Store T	2016-01-23 15:37	9.98	9.98
	Store N	2016-01-23 18:14	11.99	11.99
Sardine in tomato sauce (AYAM BRAND)	Store A	2016-01-23 16:48	4.05	4.05
	Store G	2016-01-23 17:25	3.99	3.99
	Store M	2016-01-23 14:44	3.99	3.90
	Store T	2016-01-23 15:47	4.15	4.15
	Store N	2016-01-23 18:30	3.99	3.99

Table 2 *(continue)*

Shampoo assorted (PANTENE) (350 ml)	Store A	2016-01-23 14:47	14.90	14.90
	Store G	2016-01-23 17:29	15.08	15.08
	Store M	2016-01-23 14:47	10.90	10.90
	Store T	2016-01-23 15:49	10.88	10.88
	Store N	2016-01-23 18:32	9.85	9.85
Chili sauce (LIFE) (500 g)	Store A	2016-01-23 16:54	3.65	3.65
	Store G	2016-01-23 17:32	3.81	3.81
	Store M	2016-01-23 14:49	3.40	3.40
	Store T	2016-01-23 15:52	3.59	3.59
	Store N	2016-01-23 18:35	3.55	3.55
UHT milk (DUTCH LADY) (1 L)	Store A	2016-01-23 16:56	5.95	5.95
	Store G	2016-01-23 17:34	4.98	4.98
	Store M	2016-01-23 14:51	4.99	4.99
	Store T	2016-01-23 15:55	4.99	4.99
	Store N	2016-01-23 18:37	5.50	5.50

Different prices are shown in bold in the table. This accuracy was achieved based on an average of six prices entered each week for each item at each store, hence the reason for setting mf at 3 previously i.e. at half of the expected frequency of incoming data. It is expected that a higher accuracy rate can be attained with a higher incoming rate of crowdsourced data. Apart from assessing the accuracy of the algorithm, the evaluation also obtained the following findings, which we believe are useful for crowdsourced data generally and price information specifically.

- **Erroneous data.** Users can potentially enter wrong data by mistake i.e. human error can occur. At the moment, the algorithm does not have the mechanism to deal with erroneous data of this sort. For this mechanism to be implemented, more research needs to be done to identify the range of valid values for data. Crowdsourced values that do not fall within the valid range should be discarded.

- P**rice difference.** A significant price difference can be seen for the same item at different stores i.e. up to RM3.42 in the case of the Body Wash refill pack as shown in Table 3. This supports the finding presented in Aris and Md Din (2016), and further emphasises the need to compare item prices before buying them as proposed in Aris (2015).

Complete details of the crowdsourced price information are not included in this paper due to space constraints. For the complete version, interested readers are invited to refer to the uploaded data set in Syafiq (2016).

Threats to Validity

While as much effort as possible was made to ensure the validity of this research, there were a number of constraints beyond our control that may have affected the generalisability of the research outcome. Firstly, out of hundreds of types of items sold at various stores, the survey only included 26 items and out of the many established stores in operation, the survey was done at only five supermarkets. We were not be able to cover all the items available and stores in existence due to time constraints. Furthermore, while conducting the surveys at the stores, the availability of selected items was not consistent. Certain items were out of stock for more than two weeks. In this situation, the price recorded was based on the displayed price tag on the shelf, which might not have been the same price if the item had been in stock. In addition, price changes within the week could not be detected because the surveys were only done once a week. However, people do not usually shop every week, as was reported by Aris and Din (2016). Therefore, monitoring price change on a weekly basis was regarded as sufficient. Finally, the price information gathered from the surveys did not take into consideration that the displayed price at a store might be incorrect because a price checking facility was not available at all the stores.

CONCLUSION AND FUTURE WORK

The widespread use of mobile devices and applications has resulted in the availability of an overflow of information, known as big data, and this has opened up a lot of research opportunity in the fields of managing, analysing and storing of data. Among the challenges in managing big data is ensuring that the data is correct and always up-to-date, especially if the data is dynamic in nature. In this paper, an algorithm for the automated removal of duplicate and obsolete dynamic crowdsourced data was presented as an answer to this challenge. The algorithm was evaluated by embedding it in CrowdGrocr application that crowdsources price information from the crowd. The evaluation results showed that the algorithm was able to ensure that up-to-date and correct data was stored in the database with 94.9% accuracy. Future work could incorporate a mechanism to detect outliers i.e. data that are out of valid range and more parameters to determine the accuracy of the provided data, such as location information and sender's reputation value.

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Dimensions of User Participation in Non-Profit Mobile Crowdsourcing Initiatives

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ABSTRACT

Mobile devices have seemingly become a necessity in people's daily life. They have significantly changed the way people communicate and perform their day-to-day activities. In line with this scenario, there is a practice nowadays that is gaining more and more attention from mobile application developers called crowdsourcing. The combination of the two innovations, i.e. mobile devices and crowdsourcing, promises great potential for the advancement of business and society. Despite the popularity of mobile crowdsourcing applications, special attention needs to be given to user participation, since user participation is one of the main factors that determine the success of a mobile crowdsourcing application. This study, therefore, aims at identifying the factors that influence user participation in mobile crowdsourcing application. The interview method involving 13 mobile crowdsourcing application users was used to collect the required information. The constant comparison method comprising open coding, axial coding and selective coding techniques was used to analyse the results. Findings from the analysis showed that user participation in mobile crowdsourcing applications is mainly influenced by the personal benefits that the applications can bring to the user rather than the benefit it can bring to others. These benefits cover five dimensions: financial impact, useful information provided, interaction with other users, rewards offered and features of the applications.

Keywords: Crowdsourcing, influencing factor, mobile crowdsourcing, mobile crowdsourcing application

INTRODUCTION

Crowdsourcing is a practice of distributed problem solving where problems to be solved are distributed openly to a large group of people. The term crowdsourcing was formalised by Howe (2006, pp 1-4), who defined it as "the act of taking a job traditionally performed by a designated agent (usually an employee) and outsourcing it to

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an undefined, generally large group of people in the form of an open call." Since its formal definition in 2006, crowdsourcing has evolved into various forms involving variations in terms of participants (users), process, task, content, platform and reward (Aris & Md. Din, 2016). Regardless of the variations, the following elements are at least needed in a crowdsourcing initiative to make it happen: crowdsourcer, task and crowd (Estellés-arolas & González-ladrón-de-guevara, 2012; Fuchs-Kittowski & Faust, 2014). The crowdsourcer is usually the company that initiates the crowdsourcing process by posting the available tasks online, thus it is also known as the initiator. Tasks are the problems for which solutions are sought from the crowd, while the crowd are the group of people expected to perform the tasks. Crowdsourcing has changed the way companies accomplish their tasks. Rather than hiring full-time employees to perform them, companies make tasks publicly available, usually through the Internet, for access by the crowd who can perform those tasks. This approach is said to be able to reduce operational cost as payment is made based on the solved problems and to the successful crowd only. Other reasons for companies to crowdsource include the crowd's ability to complete a task faster as the task can be decomposed and distributed to many solvers from the crowd, and the need to have high quality results performed by skilled solvers when persons with the required skills are not available locally. Besides the profit-making sector, crowdsourcing is also used by non-profit organisations, resulting in the distinction between commercial and non-profit crowdsourcing (Mckinley, 2015). Non-profit crowdsourcing is distinguished from commercial crowdsourcing in that it is performed by unpaid volunteers for the public good (Alam & Campbell, 2013; Holley, 2010). Examples of non-profit crowdsourcing initiatives include historical newspaper (Daniels, Holtze, Howard & Kuehn, 2014), Donorschoose.org (Althoff & Leskovec, 2015) and GLAM (Alam & Campbell, 2013).

With the advent of mobile communication technology, which has resulted in the ubiquity of mobile devices, a new form of crowdsourcing known as mobile crowdsourcing has emerged. Mobile crowdsourcing is a form of crowdsourcing in which tasks to be performed are made available for access by the crowd through mobile platforms and the crowd solve them also using mobile devices (Väätäjä, Sirkkunen, & Ahvenainen, 2013). The types of task to be performed in mobile crowdsourcing are usually not complex and the tasks are limited to those that can be performed using mobile devices. Looking at the growing availability, accessibility and affordability of mobile devices nowadays, the potential of mobile crowdsourcing is quite promising. A survey done involving 40,000 Internet users from across 32 countries in the United States of America and Europe showed that 80% of adults own personal smartphones, while 47% own tablets, both of which are mobile devices (Chaffey, 2017). The emerging popularity of mobile device ownership and the device's widespread availability are making it the preferred choice for the mobile crowdsourcing initiative's platforms and tools (Mea, 2013; Meeker, 2015). There are many successful mobile crowdsourcing applications (MCAs) to date, and they can be classified into a number of different categories. These categories include traffic and navigation such as Waze, and photography and design, such as iStockphoto and Threadless. More categories can be found in Mahmud and Aris (2015) that were derived from a systematic literature review of existing MCAs obtained from both research and industry. Table 1 shows in brief the profile of the three successful MCAs mentioned above with regard to their number of followers and installations.

Table 1
Profiles of MCA examples

MCA	Since	Twitter Followers	Number of Installations	Information as at
Threadless	2000	2.15 mil	-	December 2015
iStockPhoto	2000	116 K	10,000 - 50,000	January 2016
Waze	2009	197 K	100,000,000 - 500,000,000	January 2016

Based on the profiles of the three MCAs listed above, a noticeable relationship can be seen between the success of MCAs and their volume of user participation. As can be seen in Table 1, since their inception, iStockPhoto and Waze have seen 50,000 and 500 million installations, respectively, with more than 100,000 followers each on Twitter; this proves the importance of the volume of users in the success of an MCA. Up-to-date route information and constant supply of T-shirt designs and creative photos, for example, would not be available without continuous support from a large number of users.

Earlier studies concluded that crowd participation is an important element in developing successful MCAs (Andrew, 2016; Aris, 2014; Brabham, 2012; Fuchs-Kittowski & Faust, 2014; Väätäjä et al., 2013; Vreede, Nguyen, & De Vreede, 2013; Yuen, King, & Leung, 2011). Incorporating factors that influence user participation is, therefore, important in designing an MCA. Furthermore, as discovered by Shadbolt (2015), crowdsourcing in Asia is taking place at a slower rate compared to in other regions of the world. Hence, factors that influence user engagement in MCAs in the Asian region particular is worthy of study. This is especially so in non-profit MCAs, which do not normally offer monetary reward. This research aimed at identifying the factors that influence user participation in non-profit MCAs. To do so, a series of semi-structured interviews was performed involving a total of 13 participants who were users of non-profit MCAs. Information obtained from the interview sessions was analysed using the constant comparison method to identify the factors that influence these users to use MCAs.

METHOD

Qualitative research methodology was used in this study involving the use of the semi-structured interview and the constant comparison method. The interview method was used during data collection and the constant comparison method was used to analyse the collected data.

Data Collection

For data collection, semi-structured interviews using a combination of close-ended and open-ended questions were conducted. The semi-structured interview was chosen as opposed to the structured and unstructured interview as it provides interviewees with some guidance on what to talk about without limiting them to certain predefined questions only. Furthermore, this type of interview consists of several key points that help to define the areas to be explored with more flexibility and allow for the discovery or elaboration of information (Gill, Stewart, Treasure, & Chadwick, 2008). In this study, the area to be explored was the interviewees' experience in using non-profit MCAs, particularly the reasons for using the MCAs. The information to

be obtained was divided into three categories. First, common understanding on MCAs was established by identifying the participants' knowledge of MCAs. Secondly, information on the MCAs that the users once used or were currently using was sought and finally, the participants' reasons for using the mentioned MCAs were obtained. Table 2 shows the interview guide used during the interview sessions in order to ensure that the required information was captured.

Table 2
The Interview Guide
Interviewee details:

No.	Sought information	Example question	Note
1.	Identify participant's knowledge on MCA to ensure that common understanding is achieved	Do you know what an MCA is? (Provide explanation if you do not.)	
		Have you used an MCA (or are currently using one)?	
2.	Obtain information on participant's involvement in using the MCA that he/she is currently/previously using/ used	What is the MCA you have used or are using? (non-profit MCA)	
		How did you find out about this MCA?	
		How long have you been using it?	
		What is your favourite MCA?	
3.	Reasons for using MCA	Why do you use it?	
		In what ways does the MCA help you?	

Each interview session started with a brief discussion to confirm that the participant had either used an MCA before or was still using one, and to ensure common understanding about MCAs. This was necessary because some participants claimed that they did not know about MCAs, but when the researcher explained what they were, they realised that they had once used or were currently using an MCA. Therefore, at the beginning of an interview session, participants were briefed about MCAs if they claimed that they had never heard the term. When they showed that they understood what MCAs were, they were asked if they had ever used one before or was currently using one. If the answer was negative, the interview would not proceed. Otherwise, the interview session continued, following the interview guide in Table 2.

RESULTS AND ANALYSIS

A total of 13 interviews were conducted on separate occasions in October 2015. Finding potential candidates for the interviews was not that difficult due to the generality of the research objectives. Anyone who had used or was currently using MCA was eligible to participate. The sample size was deemed sufficient because for the qualitative method such as the interview, the bulk of the information comes from the initial interview sessions, with less information gathered in later interviews; at some point, no new information is observed (Bonde, 2012). This is called data saturation, which occurs by the 12th interview or as early as the ninth interview (Bonde, 2012; Galvin, 2015; Guest, Bunce, & Johnson, 2006).

Participants' Background

Each participant was given an ID, as shown in Table 3. The ID was based on the sequence of the interview series. Demographic information of the participants is presented in Table 3 together with the participants' favourite MCAs; this answered the second question in Table 2. The participants consisted of eight females and five males, who came from different occupational backgrounds. The participants, as can be seen from the table, were mainly students. The participants also came from different age groups. Coincidentally, their experience in using MCAs started at about the same time, with most having started to use MCAs in 2013.

Reasons for Using MCA

From the interview transcripts, a total of 60 discernible answers were identified and coded. Due to the different ways of answering the same given questions, each relevant answer needed to be read a few times to extract the required information i.e. the reasons for using the MCA. As an example of how this was done, consider the following excerpt taken from one of the interview transcripts.

> … I'm using Waze not because I'm not familiar with route but [because] I want to find alternative routes, the earliest expectation time of arrival because Waze informs about jam, accident. That information will cut the time of journey and make the journey easier.

Table 3
Demographics information of participants

Interviewee ID	Age Range	Gender	Occupation	MCA Used	Experience Using MCA (Since Year)
1	26-30	Male	Researcher	Waze	2013
2	21-25	Female	Teacher	Waze	2013
3	21-25	Male	Student	Swarm	2013
4	26-30	Male	Student	Waze	2013
5	21-25	Female	Student	Waze	2013
6	21-25	Female	Student	Waze	2013
7	30-40	Female	Doctor	Waze	2014
8	30-40	Female	Teacher	Waze	2013
9	40-50	Female	Lecturer	SmartShopper	2015
10	40-50	Female	Lecturer	Waze	2013
11	40-50	Male	Lecturer	Waze	2014
12	> 50	Male	Engineer	Waze	2013
13	26-30	Female	Accountant	Waze	2013

The analysed transcript containing the identified discernible answers is shown below. The discernible answers are written in bold.

> … I'm using Waze not because I'm not familiar with route but [because] I want to **find alternative routes** [obtain information on alternative routes], the **earliest expectation**

time of arrival [obtain expected arrival time] because Waze **informs about jam** [obtain information on traffic jams], **accident** [obtain information on accidents]. That information will **cut the time of journey** [reduce travel time] and **make the journey easier** [facilitate journey].

Table 4
Reasons for using MCAs

No.	Coded Reason	Source	Category	Dimension
1.	Free of charge	1, 4	No financial commitment	Financial impact
2.	Can obtain information on accidents	1, 5, 6	Obtain information on road condition	Useful information provided
3.	Can obtain information about accident location	4		
4.	Can obtain information about traffic jams	5, 6, 7		
5.	Can obtain updates about road [condition]	7		
6.	Can obtain information on alternative routes	5, 6, 8	Obtain information on alternative route(s)	
7.	Can obtain information on prices of the same item at different stores	10	Obtain information of item prices	
8.	Can obtain information on traffic officers	1	Obtain information on routes	
9.	Can obtain information on routes that charge a toll	5		
10.	Can view many things (along the route)	8		
11.	Can obtain information about/along the route	9		
12.	Can obtain information on roadblocks	4		
13.	Can obtain updated route information	2		
14.	Can obtain review of a place	3, 12, 13	Obtain review of a place	
15.	Can obtain recommendation on hotels or places to go	12		
16.	Can obtain location of a place	7, 11, 13	Obtain information on place location	
17.	Can obtain information on nearby *halal* food availability	12		
18.	Can obtain updated map	1		
19.	Can obtain expected time of arrival	6	Obtain information on expected time of arrival	
20.	Can be notified on updates	10	Timeliness (up-to-dateness) of information	
21.	Can obtain updated information	12		
22.	The information is clearly delivered	9	Clarity of information presented	

Table 4 *(continue)*

23.	Information obtained is accurate	9	Accuracy of provided information	
24.	Reduce travel time	5, 6	Secondary	
25.	Can make informed decision	12		
26.	Facilitate journey	6, 13		
27.	Can communicate with other users	4	Because of the online social networking community	Interaction with other users
28.	Can obtain feedback from other users	2		
29.	Community based	1		
30.	Opportunity to make friends	3		
31.	Can compete with other users	3		
32.	Can obtain points and badges	3	Obtain rewards	Rewards offered
33.	Can obtain reward points	3		
34.	Easy to use	3, 4, 10	User interface	Features of applications
35.	Clear interface	8		
36.	Phone compatibility	8	Device compatibility	
37.	Application that responds quickly and does not easily hang	13	Apps performance	
38.	Efficiency of MCA	1		
39.	Can customise information according to one's needs	10	Personalisation	

In this example, six discernible answers pertaining to the reasons for using an MCA, Waze, were identified from the excerpt, and these answers were coded using the terms shown in the square brackets. The process of identifying discernible answers and coding them was repeated for all relevant answers from the interview transcripts. From the 60 discernible answers, three were removed due to being repeats by the same interviewees and an additional 18 were excluded as they were repeated by different interviewees. These removals left us with a new total of 39 discernible different answers at the end of the open coding phase, the codes of which are shown in Table 4. The IDs of the interviewees who provided the reasons are also shown in the table. As can be seen in the table, the coded answers are quite specific and very much inclined towards the functionality of the MCAs used and would not be of much contribution in their present form. Furthermore, some of the answers were quite similar. Thus, in the axial coding phase, the coded reasons were further analysed to identify their categories. Eighteen categories of coded reasons were identified, as shown in Table 4. The selective coding phase using inductive analysis that further generalised the identified categories produced five themes for the reasons the participants use the MCAs. These represent dimensions of user participation in MCAs. The five dimensions were financial impact, useful information, interaction with others, rewards offered and features provided by the applications, as shown in Table 4. Figure 1 summarises the constant comparison analysis method used that led to the five identified dimensions of user participation in MCAs.

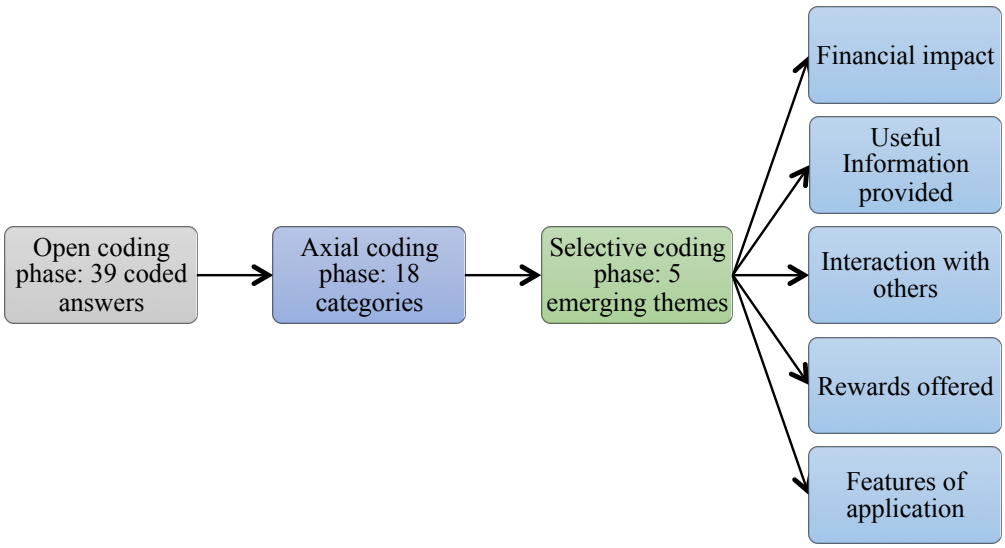

Figure 1. Summary of the constant comparison analysis method used

Useful information provided. Table 4 shows that the participants mostly used MCAs to obtain information, although the types of information varied depending on the types of MCA used. Twenty five out of 39 reasons belonged to this dimension, accounting for 64.1% of the reasons. At the highest level of abstraction, the information obtained by the participants can be divided into two: primary and secondary. Primary information is information obtained directly through MCAs, such as information on accident locations, traffic congestion and alternative routes. Secondary information is information that ensures benefits are obtained as a result of the primary information such as facilitating the journey and reducing travel time. That is, the journey is made easy when route conditions are known, while travel time can be reduced when users are able to choose shorter alternative routes or alternative routes that allow them to arrive sooner at their destination. With regard to the primary information sought, the analysis showed that it can be further divided into static, semi-dynamic and dynamic information. Static information refers to information that is unlikely to change, such as a review of a place. Semi-dynamic information can potentially change. However, the change does not take place over a short period of time. Examples of such information are locations of toll booths along a route and the prices of items at different stores. Dynamic information refers to information that changes frequently within a very short span of time. With this kind of information, updates are critical and are expected to happen within minutes. With this kind of information too, mobile applications become handy as users need to regularly check for updates. Examples of such information are traffic congestion and expected time of arrival. Regardless of whether the information is static, semi-dynamic or dynamic, it can be seen that the information is mostly needed to assist users in making informed decisions. For example, a review of a place helps users to decide whether or not to go to the location, while information on prices of items at different stores can help users to choose which store to patronise to enjoy the lowest prices. Thus, it can be concluded that the main reason that users participate in an MCA is to obtain

useful information for making informed decisions. Three characteristics, as mentioned by the participants, make information useful: clarity, timeliness and accuracy.

Financial impact. The participants mentioned that they used the MCAs because there is no fee for using the applications. They did not have to pay to have the MCAs installed on their mobile phones. This is not difficult to understand. People tend to easily download and install an application that is free for trial use because they can uninstall it later if it does not fulfil their expectation. Otherwise, they may keep it without any harm done to the wallet.

Interaction with other users. The participants also used the MCAs because the applications allowed them to communicate with other users. Through this communication, they could obtain feedback, opinions and updates from other users on common interests. Through this communication too, they could personally ask other users for specific information. This also created opportunity for making new online friends.

Rewards offered. The participants also used the MCAs because of the rewards offered for using the applications. The kinds of reward offered include points and badges. These are the gamification elements embedded into MCAs. The points and badges are usually used to rank the users, although not necessarily.

Features provided by the MCAs. Other than for the above reasons, participants also mentioned that the features supported by the MCAs were also a reason for using the applications. These features include navigability of user interfaces, which was preferred by the participants as it made the use of the MCAs easy and clear, and compatibility of the MCAs with their mobile devices. This means that they tended to use MCAs that were compatible with their existing devices.

DISCUSSION

Based on the findings from the analysis of the results obtained, the following conclusions can be made with regard to the factors that influenced user participation in non-profit MCAs in this study. Firstly, it was found that the main driving factor for users to use non-profit MCAs is personal benefit gained, such as being able to obtain traffic information that can facilitate a journey, or to obtain reviews of certain places that can help the users to make decisions about the place. This finding is in line with the finding of Aris (2014), who found that the majority of the factors influencing user participation in MCAs were due to personal benefits they brought to the user. Therefore, in this respect, there is similarity between the use of MCAs in general and non-profit MCAs. The findings of this study also extend the list of factors for using non-profit MCAs identified earlier from the literature. The new factors discovered in this study are financial impact, useful information provided and features provided.

Secondly, among the personal benefits given as reasons for using MCAs, it can be seen that obtaining information was the main reason for these participants to use MCAs. This is shown by the frequency of the occurrence of this reason, which was mentioned 20 times in

total by the participants. Thus, it can be concluded that an MCA that is able to provide useful information to users is more likely to engage and retain user participation. The implication of this finding for MCA designers is that they have to ensure that the MCAs developed are able to provide useful information to potential users, specifically, information that can help users in decision making. Other than this, making the MCAs available free of charge, with the addition of gamification and connectivity with other users as functions also contributes to user engagement. Also, attention has to be paid to the interface design of MCAs as users indicated that they preferred simple, clear and easy-to-use MCA interfaces.

CONCLUSION

This study aimed to identify reasons that influenced user participation in non-profit MCAs. From the results obtained, it was found that the users were more interested to use MCAs that could bring them personal benefits. This means that users were more interested to download and install MCAs that could help them give information and get current information. This was followed by social factors such as being able to communicate with other users in a virtual community in which users could together help solve problems. Interface design, efficiency of use and financial factors were also found to influence user participation. It is recommended that the design of MCAs take these factors into consideration to ensure successful and continuous use of MCAs. Findings from this study contribute to the existing body of knowledge by strengthening previous findings while adding more evidence to it at the same time.

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Software Engineering in an Effective Collaborative Environment: An Evaluative Study on Crowdsourcing Platforms

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ABSTRACT

Crowdsourcing gathers the world's software engineering experts on a specific subject matter, and allows organisations and individuals to employ the combined effort of these 'experts' to accomplish the software task at hand. However, leveraging the knowledge of experts will not be achieved without online crowdsourcing platforms, which makes communication possible. This study intends to evaluate the performance of four Crowdsourced Software Engineering(CSE) platforms (TopCoder, InnoCentive, AMT and Upwork) based on the criteria of the Web of System Performance (WOSP) model. The WOSP criteria include functionality, usability, security, extendibility, reliability, flexibility, connectivity and privacy. Findings from the analyses showed that the four CSE platforms vary in all of their features, and at the same time, they all lack the requirements of flexibility. The results provide insight into the current status of CSE platforms and highlight the gaps inherent in these platforms while offering a more complete picture. This study contributes to work on enhancing the design of current and future platforms.

Keywords: Collaborative environment, crowdsourcing platform, crowdsourced software engineering (CSE), web of system performance (WOSP)

INTRODUCTION

Crowdsourcing is now holding the world's attention, and has already revolutionised several aspects of human practice. The term 'crowdsourcing' was coined by Jeff Howe and Mark Robinson in Wired Magazine in June 2006 (Howe, 2006b). According to Howe (2006a) and Mao, Capra, Harman and Jia (2015), crowdsourcing is the act of organisations outsourcing their work to an undefined network of labourers, using an

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online open-call for participation. Currently, the online open-call communication process of crowdsourcing practitioners through platforms has caused great transformation in communication and networking, including TopCoder (Archak, 2010) and Amazon Mechanical Turk (AMT) (Begel, DeLine, & Zimmermann, 2010). These online platforms have made a quick move in various domains, among them involve the activities of software engineering. Software engineering is the application of engineering the development, design, implementation and maintenance of software (Laplante, 2007).

The last few years have seen great change in the manner by which software engineers develop their tasks at a high level of professionalism. This rise in professionalism lies behind the integrated series of software workers with assorted experience around the world, under the umbrella of crowdsourcing. In the world of software, crowdsourcing is growing quickly, and currently plays a critical role for most technology organisations (Dolstra, Vliegendhart, & Pouwelse, 2013). According to Mao et al. (2015), crowdsourcing has become a tool for development, testing and problem-solving in all software activities. This is referred to as "Crowdsourced Software Engineering (CSE)", and is a significantly effective tool. As stated in Stol and Fitzgerald (2014,pp.187-198), "Software engineering no longer takes place in small, isolated groups of developers, but increasingly takes place in organizations and communities involving many people."

Software organisations and individuals alike are using CSE platforms as an effective tool that has integrated software workers in order to meet software product requirements. Over the years, great contributions of online platforms have been made through many multinational organisations (e.g. IBM, L'Oracle, Dell) that offer crowdsourcing participation that focusses on several activities. This has prompted these companies to apply a crowdsourcing model to their global strategies (Li, 2016). The contribution of crowdsourcing to software engineering addresses several activities according to the software development life-cycle. Among these activities are: software requirements, design, coding, testing and verification and evolution and maintenance (Mao et al., 2015). The reasons behind the adoption of crowdsourcing by organisations and companies in their software activities are: easy access to a wide range of software workers, multiple solutions, low worker rates and reduced time-to-market (Kittur, Smus, Khamkar, & Kraut, 2011; Xiao & Paik, 2014).

This paper is an evaluative study on software crowdsourcing platforms that provide easy access to huge pools of software workers as an external solution provider. The study begins with a brief explanation of the selected CSE platforms, followed by a description of the Web of System Performance (WOSP) model and its criteria (Habbal, Chit, Ahmad, & Mahmod, 2015; Whitworth, Bañuls, Sylla, & Mahinda, 2008; Whitworth, Fjermestad, & Mahinda, 2006). Next, the details of the analysis of each criterion and a definitive review of the overall evaluation are presented. The conclusion of this study highlights the current case of online CSE platforms and proposes the required features to enhance current and future crowdsourcing platform designs.

Crowdsourced Software Engineering Platforms

Crowdsourcing platforms have received great attention through increasing demand for participation in the development of software engineering activities by users. Searches and practice show that crowdsourcing platforms are increasingly utilised by organisations for the development, designing, testing, evaluation and validation and maintenance of software applications, such as mobile applications, websites, accounting software, enterprise software and office suites (Zogaj, Bretschneider, & Leimeister, 2014).

Platforms vary from one to another in terms of task domains within software engineering context. Platforms such as TopCoder support multiple types of software engineering tasks such as coding, testing and designing (Mao, Yang, Li, & Harman, 2013). On the other hand, others are more particular such as uTest, which is designed for software testing (Gheorghe, 2015). Also, there are public platforms such as AMT and Inocentive, which are not designed for software engineering specifically, but can still be used to support multiple tasks for software engineering (Mao et al., 2015). As explained in LaToza and van der Hoek (2016), different platforms may use three different crowdsourcing models to process their individual tasks: Peer Production, Competition, and Microtasking. Peer Production contributes to software projects without managing and monetary rewards. This model has contributed to each of these projects: Wikipedia, Linux and Firefox (Wu, Tsai, & Li, 2013). As for the competition and microtasking models, both are similar in terms of monetary rewards, but differ in terms of task management. The competition model manages tasks through a series of competitions that require several days for completion. The other decomposes tasks into a set of self-contained microtasks that can be completed in a few minutes (Hoßfeld, Hirth, & Tran-Gia, 2011; LaToza, Towne, Adriano, & Van Der Hoek, 2014; Wu et al., 2013). It is clear from previous studies and the huge number of platform users that both competition and microtasking models have received broad adoption by commercial platforms. They have both helped achieve increasing speed, success and quality and have reduced the complexity of software engineering activities.

This paper evaluates four crowdsourcing platforms related to software engineering activities: TopCoder, InnoCentive, AMT and Upwork. These online crowdsourcing platforms were selected as they meet the following requirements:

- They offer support software engineering activities;
- They are a commercial platform; and
- They are accessible.

TopCoder

Topcoder is a company that manages competitions in software engineering activities. Topcoder conducts online competitions in programming known as Single Round Matches (SRMs) every two weeks. Also, it conducts weekly online competitions in graphic design and development. Design and development produce useful software that is licensed for profit by Topcoder.

Topcoder awards monetary prizes to winners and finalists of other weekly competitions or SRMs. It currently has one million registered users, who are both requesters and participants (Topcoder, 28 May, 2016).

InnoCentive. Innocentive is the global leader in open innovation, crowdsourcing and prize competitions. This company focusses on research and solving development problems in engineering, computer science, chemistry, maths, the life sciences, business and the physical sciences. Innocentive structures its activities as "challenge problems" for anyone willing to solve them. Cash rewards are offered for participants who meet the challenge criteria and offer the best solutions. The company recently announced significant traction for its Global Solver Community, with 300,000 individuals from more than 200 countries registered. More than 500,000 projects are carried out by the company (InnoCentive, 28 May 2016).

AMT. AMT is an online crowdsourcing platform for recruiting participants (called Providers in Mechanical Turk's Terms of Service or Turkers) to perform tasks known as Human Intelligence Tasks (HITs), posted by requesters. Participants can then navigate through the already existing tasks and complete them in exchange for a monetary reward set by the requester. The mechanism of paying participants for the tasks performed depends on the acceptance of the requesters. More than 500,000 participants from 190 countries are part of the company (Nichols, 21 Apr 2014).

Upwork. Upwork, formerly known as Elance-oDesk, is a global freelancing platform where software requesters can find software participants and collaborate remotely (Pofeldt, 5 May, 2015). In 2015, Elance-oDesk was rebranded as Upwork (Lunden, 5 May, 2015). Requesters of Upwork post a job and choose between hourly or fixed-price, then search for qualified participants and invite them to apply in order to complete their jobs. The mechanism of paying participants is done through hourly payment or fixed-price rates based on requesters' selections. Upwork has nine million registered freelancers and four million registered clients. Three million jobs are posted annually, equalling a total of $1 billion USD, making it a great online marketplace (Lunden, 5 May 2015).

The essential information provided by previous platforms is summarised in Table 1. A categorisation of essential information was based on Type, Industry, Foundation Year, Headquarters, Area Served, Key People and Website. The following information was derived from the company profile of each platform. Also included are some characteristics from early research on crowdsourcing platforms.

Table 1
Essential information – company profile

Essential Information	Crowdsourced Software Engineering Platforms			
	TopCoder	Upwork	AMT	InnoCentive
Type Industry	Subsidiary of Appirio Information technology staffing software outsourcing services	Private Freelance marketplace, Online outsourcing	Private Crowdsourcing Internet Marketplace	Private Crowdsourcing, Cloud labour, Open innovation, R&D, Innovation management, Product development
Founded	2001	2015	2005	2001
Headquarters	San Francisco, CA, USA	Mountain view, California	800 King Farm Boulevard, Rockville, Maryland	Waltham, Massachusetts, US
Area served	Worldwide	Worldwide	Worldwide	Worldwide
Key people	Jack Hughes	Sephane Kasriel and Thomas Layton	Mike Wiercinski	Craig Jones and Alpheus Bingham
Website	http://www.topcoder.com	http://www.upwork.com	http://www.mturk.com	http://www.innocentive.com

All the software crowdsourcing platforms described above were evaluated based on the WOSP criteria. The criteria were chosen due to their relevance to this research scope. The following section provides more details of the WOSP criteria.

Evaluation Criteria. The wosp model is an extension of the Technology Acceptance Model (TAM) (mahindra & whitworth, 2005; whitworth et al., 2008) approach by including measures based on the performance of the system, and is not based on user perception. WOSP is a theoretical framework utilised for balanced design and evaluation of advanced information systems. It analyses performance through four basic system elements: boundary, internal structure, effectors and receptors to define performance (whitworth et al., 2008). Each of these four fundamental elements can be designed to repel external threats, or to use external opportunities, contributing to eight performance goals. The eight performance goals could be categorised based on the four basic elements as effectors (functionality and usability), which have an effect on the environment and reduce action cost; boundary (security and extendibility), which is designed to prevent entry and outside objectives; structure (reliability and flexibility), which is designed for internal and external change; and receptors (connectivity and privacy), which enable and limit the ability to communicate. These criteria have been applied in the evaluation of malaysian crowdsourcing platforms conducted in 2015 (habbal et al., 2015). The wosp criteria and features used in this evaluation are listed in Table 2.

Evaluation Findings

The four platforms evaluated in this study can be classified according to their basic functionality and on whether they are dedicated platforms or public platforms. Dedicated platforms support multiple software development activities and tasks. As for public platforms are not designed for software engineering specifically, but can nevertheless be used to support various software development tasks. Each criterion was analysed based on the features related to the criterion.

Table 2
WOSP criteria (Habbal et al., 2015)

System Element	Evaluation Criteria	Description	Features	Testing
Effectors	Functionality	Ability to act effectively upon the environment	Basic functionality, Job matching (Job listings and seeking), Payment mechanism, Appraisal performance, Desktop application	Validity Testing: Input/Output Testbed
	Usability	Ability to operate efficiently or easily	Learnability, Efficiency (Task completion time), Navigation (broken links), Platform interface	Usability testing: Cognitive walkthrough, Protocol analysis, User heuristics.
	Security	A platform's ability to resist or avoid outside attack	Password, Random number, Captcha Image, Verification code	Penetration testing: Unauthorised entry probes, Attack tests
Boundary	Extendibility	Ability to use outside components or data	Openness (proprietary, tasks), Scalability, Interoperability, Compatibility (running on different browsers)	Compatibility testing: Plug-in testing, import/ export testing
Internal and External Change	Reliability	Ability to avoid or recover from internal failure	Internal Failure (Errors), Availability.	Failure testing: Load tests, disaster recovery tests
	Flexibility	Ability to change to fit outer circumstances	Adaptability, Customisability, Modifiability	Situation testing: Languages, Users, Essential functions.
Receptors	Connectivity	Ability to communicate with other systems	Interactivity, Sociability, Communicativeness	Transmission testing: Test for sending/receiving information
	Privacy	Ability to control internal information	Confidentiality, Secrecy, Ownership rights (transfer and delegation of rights)	Social testing: Test whether the community accepts the system

All the four platforms provide basic functionality to support software engineering activities and job matching facilities for job listings and seeking. A payment mechanism is featured in all the platforms, but two of these platforms have pending obstacles (Upwork and AMT). An appraisal mechanism for workers and requesters is not featured in AMT. In terms of desktop applications, only Upwork provides this as an additional mechanism to remain connected with clients for communicating and tracking time.

In terms of usability evaluation, the majority of the platforms (three out of four platforms) are easy to learn and use by anyone who speaks English i.e. TopCoder, Upwork and InnoCentive. Tasks such as job seeking and posting can be accomplished easily, as they require only a few clicks. None of the platforms provide a multi-language facility, which allows users proficient in various tongues to use and participate on these platforms, according to *Upwork* users' discussions (Upwork, 4 April ,2016), as seen in the excerpt below:

> The client speaks my other native language so I have no problem communicating with them, but now they're asking me which buttons to press in order to make a job offer/pay me/etc. Is there any way for me as a freelancer to see what the client's page looks like, so I can look at it and explain to them in my language?

On all the platforms assessed, it was observed that users are required to register and use a password for logging in. However, for verification purposes, all the platforms send links via email in order to activate user accounts and to reduce the number of spam accounts, except for AMT. Only two out of four platforms (Upwork and InnoCentive) use a captcha image for greater security.

As for extendibility, all the platforms support openness and have a high degree of accessibility to view, utilise and contribute to modify the application. Only two platforms are scalable: TopCoder and AMT. TopCoder is enabled by appirio-tech and topcoder-UML-tool as modelling tools for use in design and development competitions. AMT is scalable by providing an on-demand scalable human workforce and gives workers a selection of thousands of tasks to complete whenever convenient (Mturk, n.d.). All the platforms are compatible with all main browsers and mobile devices except for *InnoCentive*, which encounters errors with Google Chrome and Microsoft Explorer. All the four platforms are interoperable by using a third-party web and application to support their services.

Reliability indicates the likelihood that the required function is performed without failure under the conditions laid down for a certain period of time. None of the evaluated platforms have internal failure, which can cause detrimental effects on system performance. In terms of availability, only InnoCentive performed well. TopCoder and Upwork could not be found all the time, with searches returning a 404 Error, while some pages of *AMT* contained broken links.

The flexibility of the platforms was assessed. None is adaptable, customisable and modifiable. They are not adaptable because they use only the English language, and do not allow foreigners a chance to use them even if adapted with multiple domains. They are not customisable because of the absence of a feedback mechanism. They are not modifiable because they do not allow the user to either change settings themselves or to request a change.

This study also evaluated the platforms' connectivity. Connectivity indicates their ability to interact with other users as well as to link to social media tools. All the platforms feature communicativeness. The study showed that all the platforms are linked to social media sites, except for AMT. Upwork is the only platform that is interactivity-enabled by desktop application to maintain data exchange.

Privacy ensures the transfer and delegation of submission rights and personal information that cannot be viewed by unauthorised parties. Confidentiality and secrecy are covered, and users are satisfied. However, transfer and delegation of submission rights are not addressed satisfactorily by the platforms, as shown by the evaluation and suggested by users' enquiries. Table 3 summarises the findings.

Table 3
Summary of analysis

	Commercial Platforms for Crowdsourced Software Engineering			
Criteria	Dedicated platforms		Public Platforms	
(√ denotes available)	TopCoder	Upwork	AMT	InnoCentive
Functionality				
Basic functionality	√	√	√	√
Job matching	√	√	√	√
Payment mechanism	√	Pending	Pending	√
Appraisal mechanism	√	√	None	√
Desktop application	None	None	None	√
Usability				
Learnability	√	√	None	√
Efficiency	√	√	None	None
Navigation	√	√	Broken links	√
Interface	English language only and not fit page edges	English language only	English language only, unsorted and complex	English language only and email text in invalid
Security				
Password	√	√	√	√
Random Number	None	None	None	None
Captcha Image	None	√	None	√
Verification Code	Verification email	Verification email	None	Verification email
Extendibility				
Openness	√	√	√	√
Scalability	√	None	√	None
Compatibility	√	√	√	√
Interoperability	√	√	√	√
Reliability				
Internal failure	√	√	√	√
Availability	√	√	None	None

Table 3 *(continue)*

Flexibility				
Adaptability	None	None	None	None
Customisability	None	None	None	None
Modifiability	None	None	None	None
Connectivity				
Interactivity	None	√	None	None
Communicativeness	√	√	√	√
Sociability	√	√	None	√
Privacy				
Confidentiality	√	√	√	√
Secrecy	√	√	√	√
Ownership rights	Worrying	Worrying	Worrying	Worrying

CONCLUSION AND FUTURE WORK

The findings of this study show that the four crowdsourcing platforms vary in all of their features, and at the same time, all of them lack flexibility. However, the application of the WOSP model in this study provided for more ideas on system performance in terms of reliability, flexibility and connectivity, among others. The findings revealed that all the platforms provide basic functionalities such as job posting and seeking and job matching. However, secured payment, appraisal mechanisms and keeping participants connected with clients for communicating and tracking time by using desktop applications are still lacking; these must be considered. Platforms should also feature strong confidentiality mechanisms to address user transfer and delegation rights. Additionally, flexibility is not given any emphasis. These platforms should also leverage from mobile and desktop applications to promote interaction in order to keep requesters and participants more connected. In order to guide future work in this area, we advocate for further research into understanding the roles played by the feedback mechanism and desktop application in allowing more engagement between software crowdsourcing practitioners and more customisation based on their requirements. Future work may also consider the concern of practitioners of intellectual property rights and the extent of their impact on participation in crowdsourced software engineering platforms. This would in turn allow for better crowdsourcing platform designs.

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A Human-Inspired Collective Intelligence Model for Multi-Agent Based System

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ABSTRACT

The collaborative and competitive nature of multi-agent systems (MAS) is visible through the simple social mode of communication that emerges between human-agent interactions or agent-to-agent interactions. A simple mode of communication involves the fundamental actions carried out by individual agents in achieving their desired goal. The sum of these achievements contribute to the overall group goal. Comparatively, the collective intelligence (CI) of a MAS simply means that these agents should work together to produce better solutions than those made possible when using the traditional approach. In designing MAS with CI properties, formalisation of a higher level deliberation process is essential. A high level deliberation process refers to the judgement comprehension of tasks, reasoning and problem solving and planning. In this paper, we propose our Collective Intelligence Model, CIM, which has the potential to control and coordinate a high-level deliberation process of a MAS. CIM is inspired by the emerging processes of controlled discussion, argumentation and negotiation between two or more intelligent human agents. These processes screen and validate the deliberation process through a cross-fertilisation approach. The emergent property of the cross-fertilised ideas results in an intelligent solution that solves optimisation-related tasks.

Keywords: Argumentation, collective, cross-fertilisation, discussion, human, intelligence, multi-agent systems, negotiation, optimisation

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INTRODUCTION

Our research aims at highlighting Collective Intelligence, CI, as the emergent property of intelligent social interaction rather than the combined behaviour of the participants in a group. This emergent property is influenced by two attributes, which are the behaviour of

the participants and the level of cognitive capabilities engaged in intelligent social interaction (Gunasekaran, Mostafa, & Ahmad, 2013, November). We relate this to Personal Intelligence, (PI) (Gunasekaran, Mostafa, & Ahmad, 2013, December). The idea of this research is inspired by the need to understand the individual-to-individual form of collaborative work and to discover any emerging patterns that can be exploited for further enhancement. While much research work has been inspired by the collective behaviour demonstrated by swarms of insects such as ants and bees, our work investigates the characteristics of human interaction with respect to the 'knowledge' component of humans.

Our argument is that since humans are exceedingly more intelligent that insects, it would be more appropriate and necessary to discover a new approach to human collective intelligence that would produce exceedingly far better results than bio-inspired systems. We hoped to discover a generalized model of emergence of collective intelligence that could be tested on a community of software agents. Such a model is based on new concepts of knowledge components such as ideas, agreement and disagreement with multiple and cross-fertilization of ideas and knowledge.

We anticipated that a logically and mathematically complex mix of ideas, agreement and disagreement coupled with the existing knowledge of the entities would form a general model of emerging collective intelligence. We propose that if an algorithm could be developed based on the model and tested on a multi-agent system, similar results could be obtained in terms of collaborative efficiency, effective processes and possibly lower cost since the model is based on a successful outcome of decisions.

This paper attempts to study and analyze emerging collective intelligence among humans and to formulate a collective intelligence model that can be redeployed in a Multi-Agent-Based System. The following two hypotheses were tested in this study.

Hypothesis 1: There is an emerging collective intelligence in any interaction between two intelligent entities, however trivial that intelligence is.

Hypothesis 2: The emergence of collective intelligence is a consequence of the cumulative cross-fertilization of ideas and knowledge between a finite numbers of intelligent entities.

The objective of this research paper was to propose a collective intelligence model that is based on the outcome of interaction between collaborating entities.

As part of the model development, we needed to identify, study and analyze suitable and relevant face-to-face interaction between individuals and groups of people. Data gathering instruments were designed to capture the required information, characteristics, situations and context of discussion as possible variables of collective intelligence. High-impact collaborative activities were necessary to tease out the hidden concepts of collective intelligence. While we identified a few knowledge-related concepts, other concepts still need to be identified to truly model the process of arriving at a decision.

Background Study

The purpose of this background study is to learn and understand the mechanism of current CI models. We hoped to propose a CI model that uses a similar mechanism with the aim of eliminating uncertainties mainly during the simulation of MAS.

Collective Intelligence Models

Collective Intelligence (CI) models are based on streams such as self-organization, complex adaptive systems, multi-agent systems, population-based adaptive systems, swarm intelligence and swarm engineering. Some models are numerical in nature (Swarm Engineering), while others lean towards a conceptual approach (cellular automata). Here we describe the two common CI models, one inspired by nature and the other that is non-bioinspired, the Swarm Intelligence Model and the Multi-Agent System Model.

Swarm Intelligence. Swarm intelligence (si) is known for its collective problem-solving capabilities, which are inspired by the social capabilities of insects, birds, mammals, bacteria and microorganisms (bonabeau, dorigo, & theraulaz, 1999). It is the result of self-organization behavior in which the interaction of lower-level (microscopic level) components initiates the creation of a global-level (macroscopic level) dynamic structure that may be regarded as collective intelligence. It is interesting to note that using a simple set of rules in direct/indirect communication among participants in the colony leads to a global effect on the organization of the colony (matarić, 1995). Usually, local level information targets information about the local environment. The basis of si is derived from the four elements (bonabeau, sobkowski, theraulaz, & deneubourg, 1997) that structure the principle of self-organization. The elements are:

a) Positive Feedback
   This dictates a simple behavior that promotes the creation of convenient structures.

b) Negative Feedback
   This is the property to counterbalance positive feedback and help stabilize the collective pattern.

c) Fluctuation or Randomness
   This is the random walk error and the random task switching among swarm individuals that are vital for creativity and innovation.

d) Multiple Interaction
   This is interaction that involves many participants; there should be a minimum number of participants in interaction with one another to turn independent local-level activities into one interconnected living organism.

In order for this behavior to be intelligent, Millonas (1992) stated that five important principles should be evident, namely:

a) The swarm should be able to do simple space and time computations (the proximity principle).

b) The swarm should be able to respond to quality factors in the environment such as the quality of foodstuff or safety of location (the quality principle).

c) The swarm should not allocate all of its resources along excessively narrow channels and it should distribute resources into many nodes (the principle of diverse response).

d) The swarm should not change its mode of behavior upon every fluctuation of the environment (the principle of stability).

e) The swarm must be able to change behavior mode when the investment in energy is worth the computational price (the principle of adaptability).

A combination of the elements and principles have created a guideline for researchers to introduce SI optimization algorithms such as the Evolutionary algorithm, Ant Colony Optimization (ACO) algorithm, Particle Swarm Optimization (PSO) algorithm and the very recent Artificial Bee Colony (ABC) Optimization algorithm. These algorithms are deeply embedded in many applications such as the routing of traffic in telecommunication networks to the design and control algorithms for groups of autonomous robots.

Multi-Agent Systems. Multi-Agent Systems (MAS) consist of autonomous entities that are able to interact and share a common environment, which they perceive through sensors and upon which they act with actuators (Wooldridge, 2009). These autonomous entities are termed as agents. Russel and Norvig (Kaminka, 2007,pp.73) defined an agent as "an entity that can be viewed as perceiving its environment through sensors and acting upon its environment through effectors." Coen (Heylighen, 1999) viewed software agents as "programs that engage in dialogs and negotiate and coordinate the transfer of information." Wooldridge and Jennings (Bellifemine, Caire, & Greenwood, 2007) stated that an agent is "a hardware and/or software based computer system displaying the properties of autonomy, social adeptness, reactivity, and proactivity." Nwana and Ndumu (Goldstone & Janssen, 2005) defined an agent as "referring to a component of software and/or hardware, which is capable of acting exactly in order." Wooldridge and Jennings (Parker, 2008) proposed two notions of agency: weak and strong notions. They defined the weak notion as agents having autonomous, sociable, reactive and proactive characteristics. The strong notion is exhibited by the mental characteristics of knowledge, belief, desire, intention and obligation. The strong notion is also known as intentional notion. Vigorous studies in this field are aimed at developing approaches that help in building complex systems comprising of autonomous agents. Each of these agents possesses information and the ability to perform actions that are coordinated to exhibit a desired global behavior (New Challenges in Computational Collective Intelligence, 2009). It is essential to note that a multi-agent based model differs from the SI model in terms of how the models have been inspired. Nevertheless the mechanism of MAS describes major similarities with SI.

The mechanism of a MAS is as follows (International Foundation for Autonomous Agents and Multiagent Systems, 2010):

a) Agent design
Numerous MAS have been designed in different ways that consists of individual agents.

b) Environment
Agents must be able to deal and interact with their environments, which can be either static or dynamic.

c) Perception
The data that are accessed from the sensors for the agents in MAS are usually distributed.

d) Control
The control in multi-agent systems is normally decentralised.

e) Knowledge
In multi-agent systems, the amount of knowledge about the current state of the environment for every agent can differ substantially.

f) Communication
Multi-agent systems are often represented by some form of communication or interaction but normally, communication in multi-agent systems is represented as a two-way process, with senders and receivers of messages. This involves direct communication in which the agent is equipped with antennas or receptors.

These operations mobilize MAS to display the characteristics below, which make it a potential CI model:

a) Each agent has incomplete information or capability for solving the problem and, thus,has a limited viewpoint.

b) There is no system for global control.

c) Data are decentralized.

d) Computation is asynchronous.

METHOD

We used the qualitative approach to explore the phases, behaviours and tasks of a group of humans working together through intelligent social interaction. Once these behaviours and tasks were identified at the local level, our intention shifted to formalising them into adaptive sequential phases to support the global formation of the model. We strongly believed that by observing their intelligent social interaction, we would be able to tap into the behaviours and cognition activities that constitute the emerging effects of Collective Intelligence. The qualitative method strategy used was Entrography. This method allowed us to be engaged through the participative observation method, which enabled us to perform direct observation on a group of subjects in an environment that we recorded using technological gadgets such as a camera and video recorder. We also took notes and carried out informal interviews to clarify certain matters.

For the purpose of this research, we identified nine meetings. The nine meetings included five research-based meetings, two department meetings and two electrical design meetings. Out of the five research-based meetings, two were data mining projects whose goal was to predict a group of students who were weak in their studies so that early preventive measures

could be taken to help them improve. The participants of this meeting were five lecturers from Universiti Tenaga Nasional, UNITEN, and one information technology manager from the Information Technology and Multimedia Services, ITMS, division at UNITEN. The other three research-based meetings were also on a data mining project that aimed to predict and tap into the problem of electricity service payments by Tenaga Nasional Berhad (TNB) customers. The participants of this meeting were five lecturers from UNITEN and two officials from TNB. The two academic meetings were the department meetings of UNITEN academic staff involving 15 academic staff holding various positions. The last two electrical design meetings involved a team of 15 engineers (electrical, mechanical, design, etc.) with different levels of technical, ground and managerial expertise from MMC GAMUDA.

All these meetings involved participants at various positional levels (manager, senior electrical engineer, professor, senior lecturer). For the purpose of discretion, we did not disclose the goals and details of the meetings. The procedure involved in direct observation comprised five steps.

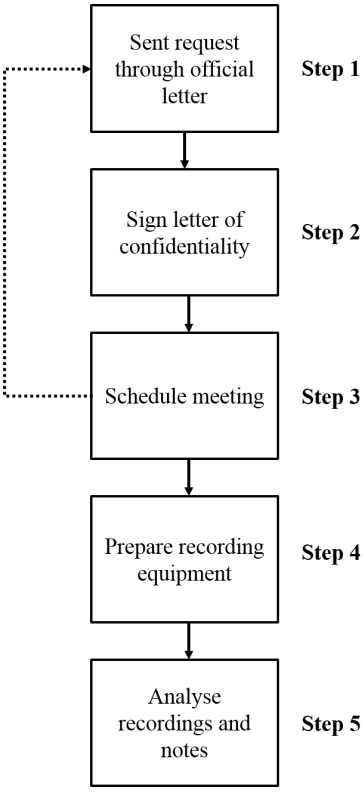

Figure 1. Observation procedure

RESULTS

In the first screening of the recorded meetings, we were able to derive the behaviour and tasks of intelligent social interaction. Table 1 below shows these behaviour and tasks as the emergent property of the nine meetings that we observed.

Table 1
Behaviour and task table

No.	Meeting	Behavior				
		Problem Understanding		Idea Reasoning		Idea Delivery
		Task				
		Knowledge Understanding	Propose Idea	Agree/ Diagree	Counter Idea	Throw Ideas
1.	Research Meeting 1	Y	Y	Y	Y	Y
2.	Follow-Up of Research Meeting 1	Y	Y	Y	Y	Y
3.	Research Meeting 2	Y	Y	Y	Y	Y
4.	Follow-Up of Research Meeting 2	Y	Y	Y	Y	Y
5.	Follow-Up of Research Meeting 2	Y	Y	Y	Y	Y
6.	Department Meeting 1	Y	Y	Y	Y	Y
7.	Follow-Up of Department Meeting 1	Y	Y	Y	Y	Y
8.	Electrical Design Meeting 1	Y	Y	Y	Y	Y
9.	Follow-Up of Electrical Design Meeting 1	Y	Y	Y	Y	Y

The results of the analysis indicated the emergence of three specific behaviours, which were problem understanding, idea reasoning and idea delivery. During problem understanding, it is pertinent to note that each participant's contribution is influenced by two factors. Firstly, the participant's knowledge reflects upon the idea of PI. Each participant's knowledge is different based on their diverse PI capacity regarding the subject matter. Secondly, the monopolisation of the meetings shows biasness by participants who have seniority and therefore, greater authority. Authority as a property is reflected by the position held by the participant in the organisation. Their positions are awarded based on the extent of their tenure. Further observation revealed that second-level behaviour involved bargaining on ideas among the participants. At this point, the tasks, 'propose idea', 'agreement/disagreement' and 'counter idea' took place. Noticeably, each of the proposed ideas was further discussed to identify its pros and cons; during this discussion, the ideas went through the agreement-disagreement process. To support ideas, specific guidelines were followed and shared by participants who were experts in that particular area. In some circumstances, external expertise was sought to support the validity of the ideas. The meeting ended when the idea that had the most pros was identified; this selection was coded as idea delivery behaviour.

Two observations were made. Firstly, there was more refined behaviour and tasks involved in regulating the communication flow of intelligent social interaction. Secondly, there was absolute meaning to the behaviour and tasks. In order to justify our observation, we conducted informal interviews with the 43 participants of the meetings. The interview was conducted at the end of the follow-up meetings and lasted 30 minutes.

The results of the interviews were threefold. First, it enabled the renaming of observed behaviour. Secondly, the behaviour and tasks could be further elaborated on and phased and thirdly, the definition of each behaviour and task was finalised. The behaviour identified was problem understanding, idea reasoning and idea delivery; these were renamed discussion, reasoning and decision making, respectively. The purpose of the renaming or rephrasing was to provide a better naming convention to represent the different behaviour. In addition, the behaviour of reasoning was seen to comprise two extended behaviours, which were argumentation and negotiation. As for the tasks, the task of knowledge understanding could be further refined to domain identification, domain familiarity and formation of a common goal, task identification, task familiarity and idea identification. Within reasoning behaviour, an additional task was added, which was idea organisation. Finally, within the decision making behaviour, the 'throw idea' task was refined to idea execution and idea storage. The number of tasks, therefore, increased from five to 13. Table 2 shows the phase, behaviour and task relationship.

Table 2
Phase, behaviour and task relationship

Phase	Behavior	Task	
Pre-Fertilization	Discussion	1.	Domain Identification
		2.	Domain Familiarity
		3.	Formation of a Common Goal
		4.	Task Identification
		5.	Task Familiarity
Pre-Fertilization	Discussion	1.	Idea Identification
Cross-Fertilization	Discussion	1.	Propose Idea
	Argumentation	1.	Disagreement
		2.	Counter Idea
	Negotiation	1.	Idea Organisation
		2.	Agreement
Post-Fertilization	Decision Making	1.	Idea Execution
		2.	Idea Storage

We were able to finalise the behaviour for the nine meetings in Table 3 below.

Table 3
A detailed version of phase, behaviour and task

No.	Meeting	Behavior												
		Phase												
		1					2	3					4	
		Discussion					Discussion	Discussion	Argumentation		Negotiation		Decision Making	
		1	2	3	4	5	1	1	1	2	1	2	1	2
1.	Research Meeting 1	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
2.	Follow-Up of Research Meeting 1	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
3.	Research Meeting 2	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
4.	Follow-Up of Research Meeting 2	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
5.	Follow-Up of Research Meeting 2	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
6.	Department Meeting 1	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
7.	Follow-Up of Department Meeting 1	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
8.	Electrical Design Meeting 1	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
9.	Follow-Up of Electrical Design Meeting 1	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

The third screening of the recorded meetings revealed that the participants of the meetings incorporated PI in pursuit of a common goal, and this resulted in the recursive behaviour of discussion, reasoning and decision-making. This behaviour and the tasks followed a recursive structure in order to stimulate a positive outcome, which ultimately represented the emergent collective intelligent. This proved the first hypothesis. Interestingly, this observation led to three important discoveries, a discussed below. (Further explanation of the definition of the behaviour and task can be read in Gunasekaran, Mostafa and Ahmad [2015]).

a) **Knowledge as the focal interaction attribute**
In our proposed CIM, we embarked on the principle of representing each participant as having his/her own PI. PI represents mental consciousness over physical and neurological capability, which is knowledge, and enabling this mental consciousness to stimulate the social structure in order to achieve goals. Success due to PI is often influenced by how one's knowledge is utilised in achieving a goal. Hence, as our CIM describes, each participant in intelligent social interaction is governed by various PI due to variant degrees of knowledge. This knowledge is shared between these participants for attaining effective decision-making solutions.

b) **Knowledge transformation process**
In effective communication, knowledge is transferred from one participant to another. There is an inherent process that guides knowledge transformation into meaningful decision-making options. The transformation takes place when experience transforms into knowledge and when that knowledge is used correctly through the execution of ideas, transforming it into intelligence. Figure 2 below shows the idea, knowledge, experience and intelligence conversion.

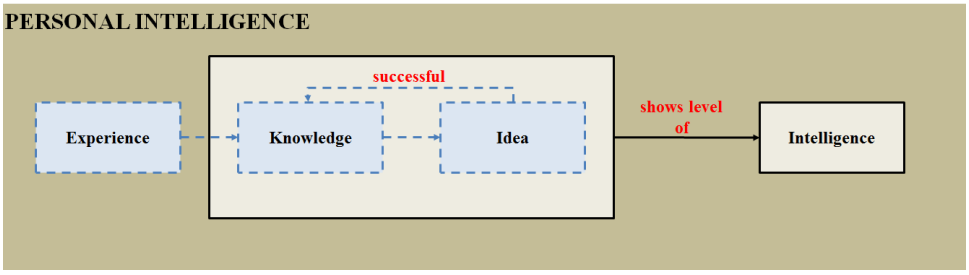

Figure 2. Idea, knowledge, experience and intelligence conversion

From our observation, it was evident that a meeting was often initiated with a discussion and proceeded when a participant in the group began the topic of discussion by conveying the initial idea on the subject matter to the other participants of the group. The purpose of this gesture was to share knowledge based on one's experience of the topic of discussion in the form of a lingual proposal. However, during the course of discussion, each participant would argue the

validity and effectiveness of the proposed idea and other corresponding ideas by referring to legitimate reasons.

Consequently, the interaction turned into argumentation when other participants would suggest counter proposals of fresh new ideas. Here, argumentation was the process of diminishing an idea with specific reasons that supported its purpose. While some group reasoning progressed smoothly, most of these reasoning processes met with a string of arguments that were ultimately resolved through negotiation. This negotiation process ensured that an agreement was reached for the purpose of decision making. Agreement progressed into action performance or more discussion depending on the potential of discussion to solve the problem. This observation indicated the existence of a knowledge transformation process in CIM. During the discussion, knowledge was extracted from prior experience and presented as ideas. Further in the reasoning behaviour, these ideas were manipulated in an iterative manner through argumentation and negotiation. Manipulation involved collaborating, competing or polarising the ideas. Collaboration reflected on the option of combining and executing the various ideas one at a time. This scenario was prevalent when both the participants had equal depth of knowledge in the domain area. Competing reflected on targeting the best idea to be selected in the decision-making behaviour. This scenario was prevalent when either one of the participants had a greater depth of knowledge in the domain or enjoyed greater authority. Polarisation reflected on the outcome of new ideas through the assimilation of two or more ideas. This scenario was prevalent when the nature of an intelligent social interaction involved immense idea generation between various participants. These collections of ideas were refined for optimal solutions requiring a continuous set of agreements, disagreements, proposals and counter proposals. Overall, once an idea or a combination of ideas had been agreed upon, a decision was made to implement the idea. In this work, if the idea contributed to a successful action-performing outcome, we called the process of manifesting the outcome as CI; otherwise, the decisions of the outcome went through another cycle of discussion, agreement and negotiation. The successful idea was then transformed into knowledge and stored in the memory for future retrieval.

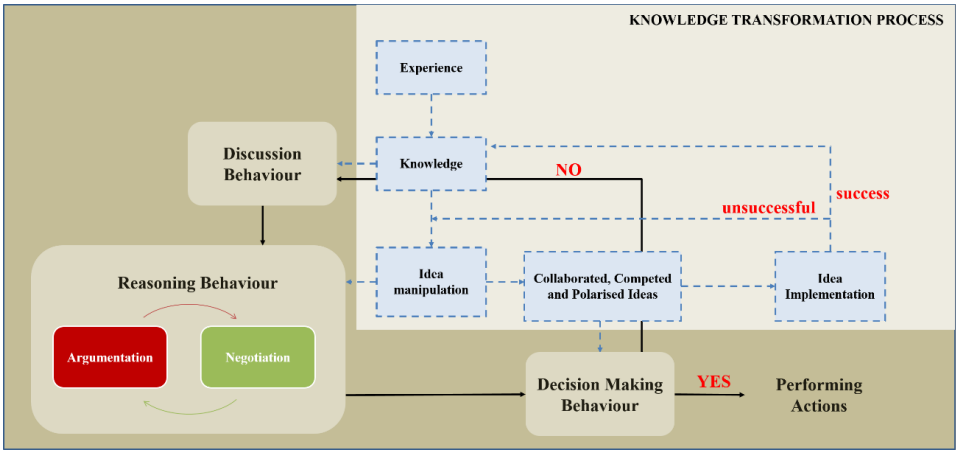

Figure 3. Knowledge transformation process

c) **Cross-Fertilisation.** Knowledge is communicated iteratively to achieve collective intelligence (goal attainment). In our proposed CIM, the intention was to derive to ideas either through collaboration, competition or intersection of the knowledge of various participants in intelligent social interaction. It was pertinent that the cross-fertilisation process took place. This proves the second hypothesis.

Our observation suggested that the cross-fertilisation process underwent three phases: the pre-fertilisation phase, the cross-fertilisation phase and the post-fertilisation phase. The categorisation of the phases with the corresponding behaviour and tasks are shown in Table 4.

Table 4
Phase, behaviour and table relationship

Phase	Behavior	Task	
Pre-Fertilization	Discussion	1.	Domain Identification
		2.	Domain Familiarity
		3.	Formation of a Common Goal
		4.	Task Identification
		5.	Task Familiarity
Pre-Fertilization	Discussion	1.	Idea Identification
Cross-Fertilization	Discussion	1.	Propose Idea
	Argumentation	1.	Disagreement
		2.	Counter Idea
	Negotiation	1.	Idea Organisation
		2.	Agreement
Post-Fertilization	Decision Making	1.	Idea Execution
		2.	Idea Storage

The pre-fertilisation phase sanctions the PI component of each participant. During this phase, each participant was capable of verifying the knowledge he/she had in accomplishing the given task. In the cross-fertilisation phase, the participants initiated interaction by communicating their individual knowledge to the other agents. In our observation, the cross-fertilisation phase underwent three levels of order.

The first level of order in the cross-fertilisation phase occurred when competition for the best ideas prevailed during the intelligent social interaction. The second level of order occurred when collaboration of ideas prevailed in the intelligent social interaction. The third level occurred when polarisation of ideas was prevalent in the intelligent social interaction. As such, each participant was equipped with varied levels of PI. As discussion, argumentation and negotiation behaviour is iterative, knowledge is diffused from one participant to another and transformed and eventually polarised. We termed this process as knowledge intersection. The diffused knowledge was deliberated concisely and acted as an added value for current and future task execution.

In the post-fertilisation phase, the participants reached a mutual decision to execute the cross-fertilised idea that was best suited for accomplishing the given task. The success of the cross-fertilised idea determined whether the idea was converted to knowledge and stored in the agent's memory for future usage. If a cross-fertilised idea is unsuccessful, it undergoes the reasoning cycle all over again.

Figure 4 is based on this and shows the proposed CIM.

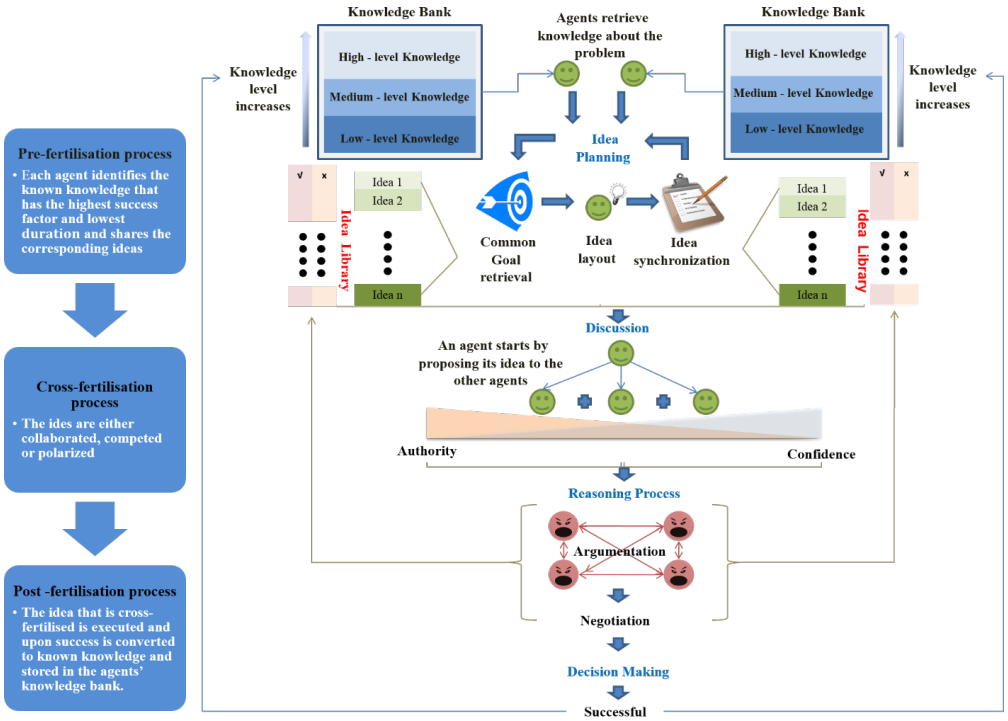

Figure 4. Collective intelligence model (CIM)

DISCUSSION

While there are many workable CI systems to support many applications, none has actually been built on a model that captures the exchanging process of intelligent behavior and cognition of interacting humans (West, 2007; Sun, 2006). All of these models are inspired by either the study of epigenetics, neurology, animals, insects, microorganism or engineering technology. Von Neumann's cellular automata focus on self-reproduction of cells; McCulloch's neural computation mobilizes the principle workings of the human brain; Darwinian evolutionary computation draws its inspiration from the dynamics of an entire species of organism; and Bonabeau and Meyer's swarm intelligence features the swarm behavior of biological organisms. All of these models focus primarily on a group-based behavioral approach.

In general, we understand that a CI model consists two levels. First is the local level that reflects the individual participants of a group. Second is the group organization, which is composed of the collective effort of the various participants at the local level. This constitutes

intelligent social interaction involving a group of humans, with each human PI represented at the local level. The various PIs communicate iteratively, which ultimately results in cross-fertilized knowledge at the global level. Both models discussed above lack this characteristic.

The SI model and the MAS focus on the collaboration factor, in which a simple mode of communication involves the fundamental actions carried out by participants to achieve their desired goal at the local level. The sum of these achievements contributes to the overall group goal. Comparatively, the collective intelligence aspects of an SI and MAS simply mean that these participants should work together to produce more efficient solutions than are possible using the traditional approach. Our challenge lay in identifying the local attributes that contribute to the global component of the new CI model.

CONCLUSION

From this case study, we were able to justify the emergence of behaviour and tasks from intelligent social interaction. Behaviour displayed was governed by two properties, authority and confidence. While authority reflected on the position the participants held in the intelligent social interaction, confidence related to their PI level. These properties created an avenue for continuous recursive behaviour to normalise the occurrence of knowledge inconsistencies among the participants. Eventually, this influenced the formation of the knowledge transformation process. The knowledge transformation process was essential in two areas. Firstly, it enabled us to construct the meta-rules to represent our CIM and secondly, it helped in strengthening the idea of cross-fertilisation, which acted as the basis of our CIM.

In conclusion, there are a few factors that describe our CIM. At the local level, each agent had differing PI. PI is influenced by the properties, authority and confidence. PI includes the sub-component of knowledge, which evolves through experience.

At the global level, the inconsistency in the knowledge depth of each participant influences the recursive behaviour of discussion, reasoning and decision making. This recursive behaviour encompasses the knowledge transformation process. The knowledge transformation process defines the three phases of cross-fertilisation, pre-fertilisation, cross-fertilisation and post-fertilisation. The cross-fertilization process manipulates the knowledge sub-component, producing an ultimate solution that acts as the precursor for collective intelligence. Knowing these factors enables us to proceed with further work on our Collective Intelligence Model that will fine-tune the model for use by multi-agent communities.

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Crowdsourcing Platform for Collecting and Rating Emotion Elicitation Media

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ABSTRACT

Giving computers the ability to understand the user's mood and feelings is the aim for affective computing field. This ability would enhance the interaction between the user and his/her computer to create advanced systems for education, commerce, security and mental disorder diagnosis, among other functions. To achieve this goal, computer software needs to be trained on big data using emotion measures. These emotions should be elicited by a standardised, replicable and validated medium. However, collecting and rating such emotion elicitation media is not a trivial task, as it involves several factors. This research aims at designing a crowdsourcing platform to collect and rate emotion elicitation media. The platform is designed such that registered users can add, recommend and rate emotion election clips, whereas researchers can access and statically analyse data about the rated clips. This crowdsourcing platform can be used by emotion researchers to collect highly- rated emotion elicitation media, and by individuals through social media platform to share emotion elicitation media. The highly-rated clips could be used to elicit emotions, which then could be used to create models for automatic emotion recognition. The automation of emotion recognition will benefit different fields such as health (physical and mental), education and technology.

Keywords: Crowdsource platform, emotion elicitation, emotion recognition, human-computer interaction, media collection

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INTRODUCTION

Human-Computer Interaction (HCI) in general and in affective computing in particular has an interest in emotion recognition. This interest has increased with a view towards implementing advance intelligent systems that interact with users based on their feelings. Such intelligent systems would improve user perception of software and their provided

services (Pantic, Pentland, Nijholt, & Huang, 2006). For example, when including effect-state recognition in a remote educational system, presentation style, content complexity and task difficulty could be adjusted based on the emotional state of the student (Craig, Graesser, Sullins, & Gholson, 2004). Advertisements on e-commerce contexts could be personalised by understanding the clients' preference based on their current mood (Zhou, Ji, & Jiao, 2012). Smart surveillance systems could use people emotions, mood and behaviour to detect abnormal activities for security and safety assurance (Tao & Tan, 2005). Emotion and mood recognition have become an active research area recently to support and assist psychologists in diagnosing mental disorders such as depression (Alghowinem, Goecke, Wagner, Epps, Breakspear, & Parker, 2012).

To give the computer the ability to recognise emotions, big data of emotion measures have to be collected for each emotion. Regardless of the sensors used to collect these measures, the investigated emotions have to be elicited in a replicable way between subjects. Psychologists have investigated several methods to induce emotions (Westermann, Spies, Stahl, & Hesse, 1996). These methods are categorised in three categories: (1) acted or posed emotions, where actors are asked to perform a certain emotion, (2) induced emotions, where stimuli are used to evoke emotional response, such as looking at pictures, listening to music, watching videos and reading texts, and (3) naturalistic displays of emotion involving subjects in conversation (Kory & D'Mello, 2014). These emotion-inducing methods vary by several factors, including emotion sensory measures, intensity and duration of response, reliability and ecological validity (Kory & D'Mello, 2014). Nevertheless, watching film clips has proven to be effective in emotion elicitation for its advantages compared to other techniques (Zeng, Pantic, Roisman, & Huang, 2009; Jerritta, Murugappan, Nagarajan, & Wan, 2011).

For a clip to be suitable for eliciting emotions, several criteria have to be taken into account. The differences between clips have to be controlled so that comparisons of emotion elicitation would be due to the emotions, not to differences in the clips. These criteria include clip duration and intensity of elicited emotion etc. One of the most serious challenges in selecting emotional clips is to ensure that the selected clip only induces the target emotion and not unintended or mixed emotions. Several studies have investigated and validated such emotion elicitation clips. A list of validated clips has been made available in Gross and Levenson (1995) and Schaefer, Nils, Sanchez and Philippot (2010). However, the validation method of selecting these clips used a relatively small number of subjects and did not consider the subjects' cultural background. Since emotions are subjective, a large number of subjects are required to compensate for this issue. Moreover, emotions are influenced by cultural background of subjects. For instance, different emotions could be induced by the same set of elicitation clips among different cultures.

In this paper, we propose a design for a crowdsourcing platform to collect and rate emotion elicitation media. The proposed platform utilises the power of the crowd to share and rate emotion elicitation media. For individuals, the suggested platform could be seen as a social media platform. For emotion researchers, this platform could be used as a crowdsourcing platform to select highly-rated emotion elicitation media for emotion elicitation studies.

BACKGROUND AND RELATED WORK

Emotion Representation in Psychology

Defining each emotion is a critical first step in collecting eliciting stimuli. Yet, definitions of emotions in psychology literature are highly controversial. Emotion representations can be divided into categorical and dimensional representations. Categorical emotion representations include simple (i.e. positive vs. negative emotions) and discrete (i.e. specified set of emotions) representations. A well-known emotion category has been suggested by Ekman, who categorised emotions as six basic emotions: anger, disgust, fear, happiness, sadness and surprise (Ekman, 1992). Since emotions are complex and mixed in nature, dimensional emotion representations have been proposed. The dimensional emotion theory includes two well-known models: two dimensional (2-D) and three dimensional (3-D) models. The two-dimensional emotion model has two axes, valence and arousal, as proposed by Jaimes and Sebe (2007) and Russell (1979). The three-dimensional emotion model was proposed by Kehrein (2002), Schroder, Cowie, Douglas Cowie, Westerdijk and Gielen, (2001) and Wundt, (2009). The three dimensions are valence, arousal and dominance, and they range from weak to strong. In effective computing and automated emotion recognition, categorical emotion representations are mostly used. That is due to their suitability as labelled classes in the classification task. Therefore, in this study emphasis is given to Ekman's set of emotions, not only for their classification suitability, but also for their universality in cross-cultural contexts (Ekman, 1992).

As mentioned earlier, several techniques exist to elicit emotions, with eliciting emotions by watching video clips being the most effective technique (Westermann et al., 1996; Schaefer et al., 2010). Eliciting emotions by watching video clips has several advantages compared to other methods. Typically, films are an artificial reflection of real life, but without ethical boundaries. Films can elicit strong subjective and physiological changes (Gross & Levenson, 1995). Video clips can induce mixed emotions with different levels of arousal. Therefore, selecting film clips should be done carefully and have to be validated to elicit related emotions.

Several studies have been conducted to collect and validate emotions elicited by movie clips. In an early Western study by Philippot (1993), 12 emotion elicitation film clips were collected to elicit six emotions. Subsequently, Gross and Levenson (1995) collected emotion elicitation films with the help of film critics, video store employees and film buffs for nomination. Over 250 films were evaluated and selected carefully to yield a filtered list of 78 clips. They showed the clips to 494 English-speaking subjects. Based on the subjects' evaluation of these clips, a shorter list of 16 films for eliciting eight targeted emotions was filtered. However, these lists can now be considered outdated. In a recent study, 70 French-speaking movie clips collected from different cultural backgrounds (French, Italian, British and American) were validated (Schaefer et al. 2010). Another recent study presented a validated emotion elicitation Spanish-dubbed set of clips (Fernandez, Pascual, Soler, & Fernandez Abascal, 2011). However, a known gap of the above studies is that the selected population for validating the clips were mostly young, which may have affected the result. Another important limitation is the cultural differences between both the selected clips and subjects, which play a critical role in emotion trigger for audiences.

As mentioned earlier, collecting video clips for emotion elicitation should consider several factors carefully. Duration of the emotion elicitation video is one of the most important factors,

due to its effect on the emotion latency, rise time and offset. A short 1- to 2-minute clip is desirable for this purpose. Typically, emotion elicitation video clips are part of a film or a play. Therefore, the selection of the emotion elicitation clip should be self-explanatory and should consider inducing emotions without additional background explanation or additional contexts. Moreover, the selected clip should induce the target emotion and not a mix of emotions or non-target emotions. The intensity of inducing the target emotion should be recorded and used as a measure for clip selection. Most importantly, the selection of the clips should consider cultural acceptance based on the cultural background of the intended subjects.

It is well-known that cultures affect the elicitation of emotions from certain clips. Studies investigating different cultures by Mesquita, Frijda and Scherer (1997) and Richerson and Boyd (2008) concluded that emotion responses and triggers differ from one culture to another. Sato, Noguchi and Yoshikawa (2007) discussed cultural influences on emotional responses. The study applied the same video clip stimuli developed by Gross and Levenson (1995) on Japanese participants. It has been reported that non-target emotions have been elicited (i.e. excitement, embarrassment and surprise) while watching the amusement film. One possible reason for this inconsistency is that the amusement clip, which shows a woman pretending to act out a sexual behaviour, is not culturally accepted by the Japanese. A previous cross-cultural study on sexual permissiveness reported that the Japanese are more conservative than Americans. Thus, cultural differences affect the emotional response towards film clips. Collecting and evaluating lists of emotion eliciting film clips should suit the cultural background of the intended subjects.

Automatic Recognition of Emotions

HCI is being increasingly recognised and promoted as an important aspect of software systems and products (Buie, 1997). One of the improvements in HCI is the inclusion of automated emotion recognition. To give the computer the ability to recognise emotions, the full process of pattern recognition steps is required. This includes data collection, data pre-processing, feature extraction and classification. Affective computing measures and techniques have been surveyed by Calvo and D'Mello (2010). Regardless of the emotion model/categories used, emotions can be detected using different modalities such as speech, facial expression, body gesture and physiology signals etc. (Calvo & D'Mello, 2010; Pan-tic & Rothkrantz, 2003; Wu, Parsons, Mower, & Narayanan, 2010). These modalities measure objective physical response to emotions using different sensors/devices (e.g. microphone, camera).

Regardless of the modality used to automatically recognise emotions, the computer has to be trained from a big sample of observations. To obtain accurate automated emotion recognition, supervised machine learning is preferred (Mohri, Rostamizadeh, & Talwalkar, 2012). In supervised learning, the classifier learns from labelled training observations, and then applies the resulted classification model to new unseen observations (testing data). Hence, the performance of supervised learning techniques depends on the quality of the training data and the quality of the labels.

However, emotion labelled training data from experts is expensive and requires time and effort. Moreover, since the emotions are highly subjective, expert labelling of emotions

should be validated by a big sample of the population. Tarasov, Delany and Cullen (2010) have shown that it might be impossible or too expensive to acquire actual emotion labels. Thus, they used crowdsourcing platforms to recruit and encourage public annotators to annotate and label emotions from already chosen speech data. Our proposed platform focusses on both collecting and rating elicited emotions from the public using video clips. The following section (Crowdsourcing Platforms for Emotions) elaborates on using crowdsourcing in labelling emotions.

Moreover, most automated emotion recognition systems use emotional stimuli to induce emotions. These stimuli are usually selected from experts and assume the elicitation of the target emotion. As mentioned in the previous section, these stimuli need to be collected, rated and validated for their effectiveness in eliciting the intended emotions.

To sum up, to have accurate automated emotion detection labelled emotion data is preferred for training. While emotion stimuli responses used for automated emotion detection are being measured objectively using sensors, emotion labels are highly subjective. Therefore, a refined and validated stimuli list that induces the target emotions should be collected and rated by experts as well as by big samples of the population. This research aimed to design a crowdsourcing platform for this purpose.

Crowdsourcing Platforms for Emotions. Crowdsourcing is the practice of dividing labour between large numbers of (typically online) workers. It is a promising method for outsourcing (Hupont, Lebreton, Mki, Skodras, & Hirth, 2014). Another definition of crowdsourcing is the act of breaking down work into many small independent units and distributing them among a large number of people, usually over the web (Mohammad & Turney, 2013). Crowdsourcing can be a fast, cheap and effective way to collect data from a wide range of demographics.

Due to the expansion of online social networks, the crowd have been utilised for emotion studies. Using crowdsourcing platforms in affective computing could enhance the process of obtaining emotion elicitation media and rating and validating these media and annotating and labelling emotional media. Several studies have been conducted utilising crowdsourcing platforms to label emotional speech (Tarasov et al., 2010), annotate facial responses to online videos (McDu, El Kaliouby, & Picard, 2015), annotate videos (Soleymani & Larson, 2010) and label emotion in response to music (Morton, Speck, Schmidt, & Kim, 2010). In Hupont et al. (2014), reliability of crowd rating emotional images have been investigated, where the rating scales were compared with laboratory-set rating. The results showed that the crowdsourcing platform was efficient and effective. As can be seen, most of these affect studies that utilised crowds focussed on annotation and labelling emotions from different media. None of the studies was aimed at collecting and rating emotion elicitation video clips. Therefore, our proposed platform could help overcome the limitations of previous studies. Nevertheless, utilising crowds to collect and rate emotion elicitation clips is challenging and may introduce uncontrolled variables due to collecting highly subjective perceptions of emotions from a wide range of participants from different cultures, languages, knowledge background etc.

Therefore, this research utilises crowdsourcing to collect and rate emotion elicitation media by designing a crowdsourcing platform. In this platform, participants' general information

and demographics will be recorded to allow for accurate filtering and analysis of both clips and participants by emotion researchers. For individuals, this platform can be seen as a social media platform for sharing emotion-related information.

Design of Crowdsourcing for Emotion Elicitation Media. The proposed crowdsourcing platform is aimed at emotion researchers who must select emotion elicitation clips. To achieve this, the emotion elicitation media have to be collected and rated by the crowd. In this study, the participants registered their information and demographics for filtering of the results of the collected clips as well as their rating. The following sections analyse each component of the proposed platform. Figure 1 elaborates on the proposed software architecture from the viewpoint of users.

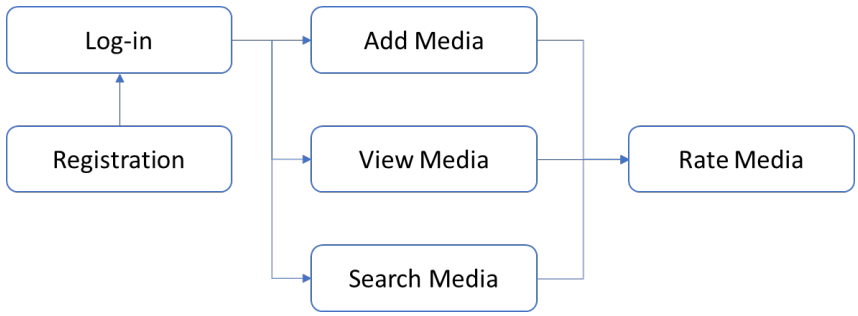

Figure 1. General design of software architecture from the viewpoint of users

Collecting Media. Gross and Levenson (1995) collected emotion elicitation clips for their study from film critics and experts. Even though an expert view is important for such a collection, it may not always be available. Therefore, besides involving experts, film creators and film critics in collecting emotional content for the platform, crowdsourcing was also utilised. The proposed crowdsourcing platform will involve the general public in adding emotional video clips. Clips can be segments from various resources such as films, series, plays or any source that stimulates emotions. However, for privacy and ethical reasons personal or real-life recordings should not be accepted. Participants wishing to add emotional clips could perform this task in two ways. They may refer to the source of the segment (e.g. film or series name, episode number), the start and the end time of the segment and the target emotion. Other participants or experts could then segment and upload the referred emotional elicitation segment. The second way is to directly upload the segment. A functionality for reporting unrelated clips would be made available to focus on rating and validating emotion-elicitation related clips.

Rating Media. The most important functionality of the proposed crowdsourcing platform is to utilise the crowd for rating the collected emotional clips. Since the clips might be mostly selected by experts, rating the clips is a critical component of the proposed platform. The scores for rating the selected media will result in producing a list of clips that elicit certain emotions. After watching each clip, the user rates the emotions elicited and the emotion intensity (arousal).

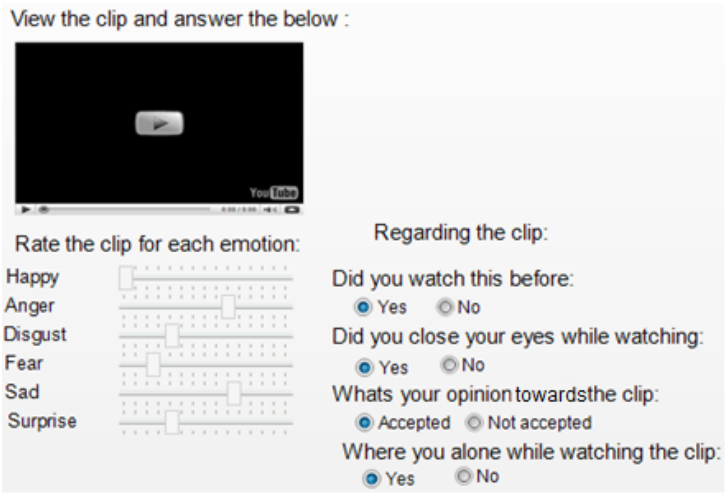

Figure 2. Design interface of the software

The emotions are the six universal Ekman categories: happy, anger, disgust, fear, sad and surprise (Ekman, 1992). The intensity of emotions will be evaluated on a scale of 0-10, with 0 representing emotion that was 'not felt', while 10 was an 'extremely felt' emotion (see Figure 2). Users will be able to rate one or more emotion category; this would help in eliminating clips that induce highly mixed emotions.

The user will answer general questions about the clips that might affect the user's rating of the emotion. For example, if the user is watching the clip with a group of people their rating might be affected (e.g. they might feel embarrassed to show their actual emotion or may experience elevated intensity of amusement as a result of being in a group). Cultural acceptance questions are to be included to give emotion researchers the flexibility to exclude clips with low cultural acceptance.

A threshold of the number of clips to be viewed by users at a time could be set to reduce the effect on emotion rating. Behavioural analysis of user rating could be used to determine if blocking clip viewing from the user is required. If the user rated several clips with high intensity of sadness, the platform blocks the user from viewing clips for a certain time frame.

Participant Registration. Since the main goal of this platform is research use, demographic information is critical as it is needed for the analysis of the collected and rated clips. Therefore, users are required to register, filling in general information about themselves and answering demographic questions for that one time only. The user may then add and rate media without having to re-enter demographic information. The demographic questions take into consideration cultural information and background. Demographic information will be used for filtering and analysing the collected and rated media. Users from age 13 and above may participate and rate all clips. Some specific clips are shown to kids and their rating activities are limited to those clips only. Videos are filtered to suit the age stated in the registration form.

Search Filters. Searching and filtering the clips is enabled for both researchers and users. Users will be able to search and select clips they want to watch based on language, culture and target emotion. For example, a user wishing to watch amusement elicitation clips may filter the clips for amusement emotion. Users with no preference will be shown a random selection of clips. However, with a random view the user has no expectation of what emotion will be viewed. Thus, to avoid the variability of continuous clip order in the analysis, as well as to assure the rating will not be effected by the previous clip, viewing a natural clip has been suggested (Maffei et al., 2014; Bednarski, 2012; Bartolini, 2011). However, in our case, the rating and the questions for each clip could act as a naturalising of emotions.

For emotion researchers, search filters are used for data analysis and media collections. The process where researchers could conduct their evaluation is explained in the following section.

Selecting Emotion Elicitation Media - Research Methodology. The main purpose of the proposed crowdsourcing platform is to facilitate the collection and rating of emotion elicitation media for emotion analysis investigation. The selected media should elicit emotions in a replicable way, and should be evaluated and validated for their capacity of eliciting the target emotion.

As mentioned earlier, emotion elicitation media are to be collected by experts such as film creators, directors and film critics as well as the general public through crowdsourcing platforms. The collection of emotion-inducing media using crowdsourcing platforms will ensure a wide range of demographics; cultural background, for instance would vary greatly. The crowd are expected to rate the emotions and their intensity as elicited by each medium they view. The crowdsourcing platform is used to ensure a wide range of demographic samples not only for collecting emotional clips, but also for rating the effectiveness of the clips in eliciting the target emotion. The proposed platform has the following main functionalities:

- Registration: The user signs up once and then uses his or her username and password for log-in. During registration, the user should fill demographic questions, as described earlier. This will allow for demographic questions to be stored and filled in by the user only once to avoid having to repeat the procedure, which many find tedious. Researchers who use the software will have a different access route, which will allow review of the results and analysis.
- Adding videos: Video clips can be added by both experts and registered users (crowdsourcing).
- Rating videos: Questions will appear after watching each video to rate the elicited emotions. After collecting these ratings, a standard list of clips can be obtained that could then be used to create models for automatic emotion recognition.
- Search video: The user will be able to filter and view clips by different categories.
- Analysing rated videos: The researchers have access to the demographic questions and the rated videos to help them filter the results based on their research needs.

Once the media have been collected and rated for emotional elicitation effect, emotion researchers may analyse the emotion elicitation rating. This analysis would evaluate the emotion-inducing media to filter a desired set of clips that are effective in inducing the target emotion or combination of emotions.

DATA ANALYSIS AND EVALUATION

As mentioned earlier, the proposed platform utilises a crowdsourcing environment to collect and rate emotion stimuli. Several data analysis functionalities and filtering queries will be provided by the platform to aid emotion researchers to evaluate the effectiveness of the clips in inducing the target emotion(s).

The evaluation is done by filtering the big pool of collected media from the experts and the crowd to a refined list based on the elicitation rating of target and non-target emotions, that is, the media have to be analysed based on target vs. non-target emotions. For example, media that elicit mixed emotions could be eliminated for studies that focus on single-emotion elicitation. This could be done based on the statistical analysis results, where the clips with the minimum mix of non-target emotions will be categorised as single emotion. Statistical analysis could indicate the clips with the maximum mix of certain emotions, such as clips that can elicit the feelings of fear and disgust at the same time.

For gender difference evaluation, the T-test, for example, could be used; this is provided by the platform. Alternatively, comparing emotion groups could utilise ANOVA and/or chi-squared statistical tests to analyse the correlation between the subjects' emotion elicitation rating and the clip's emotion category. Other different variables could be analysed and used as filtering queries of emotion analysis based on the demographic sample, such as age, cultural background, educational level, interests etc. An example of emotion analysis by Sato et al. (2007) saw them analysing clips by discrete emotions by viewing the film, 'When Harry Met Sally' to measure the amusement emotion, as seen in Figure 3, for target and non-target emotions.

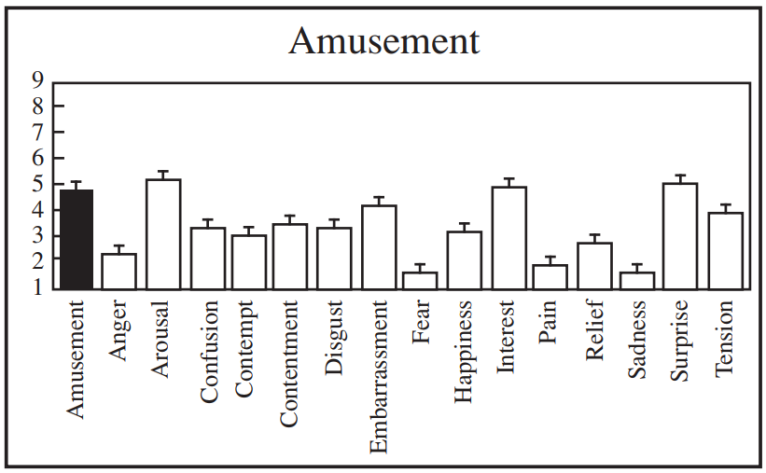

Figure 3. Example of emotion analysis from amusement elicitation clip (Sato et al., 2007)

Validation

Based on the data analysis and evaluation, emotion researchers would be able to refine a set of emotion elicitation clips that is customised for their research. Depending on the researchers' investigation, validating the refined clips could use different approaches. The validation step is a critical step for measuring the effect of the emotion-inducing media on a small sample, before these media are used for collecting big data of emotional measures.

To measure emotional response to the refined stimuli, several devices may be used. Besides using a camera to measure facial responses to emotion stimuli, different wearable devices may be used to measure physiological responses. Such devices could measure heart rate, body temperature and skin conductance level. The signals from each of these sensors should be pre-processed for extracting features that facilitate the recognition of emotions. The classification performance would measure the accuracy of recognising the labelled rated elicited emotions from the clips with the physiological responses.

A variety of sensors have been used in emotion recognition literature. For catching facial expression a device called Microsoft Kinect and its SDK (Software Development Kit) have been used for extracting facial responses (Zhang, 2012). Previous studies have used, for instance, the Tobii Eye Tracker device to measure eye responses to stimuli to recognise positive and negative emotions (Alghowinem, Alshehri, Goecke, & Wagner, 2014). For skin conductance level and temperature, some studies have used a Q-sensor (Al-Mutairi, Alghowinem, & Al-Wabil, 2015). While the mentioned devices are only examples, several other devices have been used, as cited in emotion recognition literature, for detection of a variety of emotion categories and emotion models as mentioned earlier (Calvo & D'Mello, 2010).

Once the refined list of emotion elicitation media has been validated with classification and physiological measures, the final step is to collect big data of emotional measures. This data are to be used to create a trained supervised model for each emotion using specific physiological measures. These models are then used to give the computer the ability to recognise the user's feelings. Because emotions are highly subjective, having a big sample of different demographics of subjects would allow for creating emotion models specific for different variables. Specificity of training emotion models would increase the accuracy of emotion recognition.

CONCLUSION

Acknowledging the importance of recognising and detecting users' emotions to enhance user interaction with a variety of systems, system developers have been investigating methods of emotion recognition. Such intelligent systems could have a positive influence in several fields including Human-Computer Interaction, psychology, neurobiology, sociology and marketing. To give computers the ability to recognise emotions, they should be trained using big data of emotion measures. To obtain emotion measures from big samples of subjects, a validated emotion elicitation trigger should be collected. Several emotion elicitation methods have been investigated, and video clips have proven to be the most effective. Several studies have collected emotion elicitation clips, yet these studies used only a limited demographic sample. Moreover, the selected clips from these studies might not have a universality effect on different cultures. Therefore, this research aimed to design a crowdsourcing platform to collect and rate emotion

elicitation media from a wide demographic sample with consideration of cultural background. The main aim of this crowdsourcing platform is to help emotion researchers to collect and evaluate highly-rated emotion elicitation media. For individuals, this platform could be seen as a social-media platform for sharing and rating emotional media. Using filtering and analysis functionality of the platform, emotion researchers can select, evaluate and validate the rated media. Evaluation of the media could be performed to select, for example, the media that highly elicit the target emotion and to eliminate the media that elicit mixed emotions. Another example is to select the media that elicit a certain combination of emotions. For validating the evaluated media, measuring physiological signals and reaction (e.g. facial response) could be performed using wearable devices. Once the emotion elicitation media have been validated for their effectiveness, data collection of emotion measures can be performed.

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Crowdsourcing for Ideas: A Review of Motivational Factors and Challenges in Open Innovation Communities

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ABSTRACT

Crowdsourcing introduces new perspectives in innovation, allowing for new products and services to shift away from the traditional manufacture-centric model to a more user-centric one. In order for businesses to reap the benefits of open innovation, it is necessary to understand the factors that motivate ideators to contribute valuable ideas. Equally, there is an urgency to identify the challenges faced by ideators in crowdsourcing for open innovation to retain the participants of crowdsourcing communities. This paper presents a structured review to address the aforementioned issues. Our findings reveal that the intrinsic factors that drive participation in open innovation are related to the learning experience that results from sharing ideas. Extrinsic factors like social motivation are frequently mentioned in different studies. This study also highlights the need for organisations to develop strategies for interacting with their contributors in order to sustain their participation and idea contribution. In conclusion, this paper can serve as a guideline for practitioners to improve crowdsourcing platforms with the inclusion of important motivational features. It can also serve as reference for organisations for formulating policies to regulate idea contribution.

Keywords: Crowdsourcing, open innovation, motivational factors, crowdsourcing challenges

INTRODUCTION

Traditional businesses and institutions have relied primarily on their internal R&D department to innovate and sustain innovations. However, the exponential and rapid development of information and communication technology, as well as the emergence of Web 2.0 have pushed businesses to seek innovative ways to design and develop their products and services (Geiger, Seedorf, Schulze, Nickerson, & Schader, 2011). Today,

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businesses leverage on the power of the Internet as well as the skills and knowledge of a large number of voluntary external contributors to perform tasks traditionally carried out internally. This concept, aptly dubbed 'crowdsourcing', has changed how businesses are run.

The term 'crowdsourcing' was first coined in 1998 and can be defined as the act of outsourcing a task, previously performed internally in an organisation, to individuals or a pool of people through an open call commonly via the Internet (Schenk & Guittard, 2011). The tasks in crowdsourcing could be tasks that require basic computing skills such as data entry or more complex tasks such as product design.

Crowdsourcing also introduces new perspectives into innovation where products and services are a shift away from the traditional manufacture-centric model to a more user-centric one, better satisfying user requirements (Schweisfurth, Raasch, & Herstatt, 2011). These ongoing crowdsourcing communities attract the attention of companies because consumers are presumably aware of their own problems with existing products, and they are intrinsically motivated to freely share their ideas about the expected products features (Hippel, 2005; Füller, 2010; Zhao & Zhu, 2014). This can only be done under the right conditions and platforms from which ideators generate valuable ideas for an organisation to implement (Kavadias & Sommer 2009; Magnusson, 2009; Poetz & Schreier, 2012).

User innovation community, an open business model, is gaining attention. It is a community in which ideators participate with an organisation` in research and development efforts. The possible benefits from these ongoing communities include direct contact with customers as well as consumer input into the innovation process that is better, faster and cheaper than traditional market research (Boutin, 2006; Howe, 2008).

Ideators spend time and effort submitting and responding to ideas, wanting to engage with product development. Therefore, communicating with them requires a concerted effort from an organisation as the organisation has to understand the ideas contributed, identify the best ones and develop communication strategies that align with the new role customers play within the organisation's innovation process. The purpose of this article is to identify the main factors that encourage ideators to contribute the types of ideas, an organisation desires to implement. Furthermore, we discuss the key challenges faced by ideators in these crowdsourcing communities.

METHOD

This paper presents a structured review of recently published literature relating to the topic of crowdsourcing for ideas in open innovation context. Papers were retrieved from Scopus and Google Scholar using keywords like 'Crowdsourcing for Ideas', 'Open Innovation', and 'Motivation for Crowdsourcing and Challenges for Crowdsourcing'. These keywords shown in the left column of Table 1, were then searched using Boolean search queries. Papers with more than 10 citations (higher impact) were included for analysis.

Table 1
Keywords used to retrieve papers related to the topic of crowdsourcing for ideas in open innovation

Search Term	No. of Papers	Publication Type (No. per type)
Open innovation	10	Conference papers (0)
		Journal articles (9)
		Book chapters (1)
Crowdsourcing for ideas	6	Conference papers (1)
		Journal articles (5)
		Book chapters (0)
Challenges for open innovation	6	Conference papers (2)
		Journal articles (4)
		Book chapters (0)
Motivation for crowdsourcing	8	Conference papers (2)
		Journal articles (6)
		Book chapters (0)

In total, 30 papers were found using the defined Boolean search queries. The papers included for analysis were dated from 2008 to 2016. These papers were classified into major categories: motivational factors and challenges in crowdsourcing in open innovation.

The following section discusses the important motivational factors identified from the papers and key challenges faced in current open innovation.

RESULTS AND DISCUSSIONS

Motivational Factors Influencing Participation in Open Innovation Communities

The motivational factors were analysed and classified using the Kaufmann and Veit (2011) motivational model. Kaufmann and Veit (2011) refined intrinsic motivation into personal intrinsic (enjoyment based) and community based. Our findings demonstrated that while the general framework of the Kaufmann and Veit (2011) motivational model could be applied, the factors that led to intrinsic enjoyment were different from the factors identified for crowdsourcing for tasks. In task-based crowdsourcing application, the factors that led to enjoyment (an intrinsic factor) were mostly related to the task characteristics and design such as task autonomy and task identity. In contrast, in crowdsourcing for ideas, the factors that led to enjoyment were based on learning experience (Ståhlbröst & Bergvall-Kåreborn, 2011), curiosity (Ståhlbröst & Bergvall-Kåreborn, 2011) and intellectual stimulation (Lakhani & Wolf, 2003) resulting from participating in open innovation. For example, studies have demonstrated how participants loved to respond to challenging questions and gathering different viewpoints (Muhdi, Daiber, Friesike & Boutellier, 2011). Another emergent intrinsic enjoyment-based factor was sense of efficiency, which encapsulates aspects like triggering creativity and innovation, self-development and increasing efficiency.

As for the extrinsic factors, similar motivational factors evident in crowdsourcing for tasks were observed (Hossain, 2012). For immediate extrinsic motivation, monetary rewards

and the desire to win something emerged as main factors. Equally, for delayed extrinsic factors, similar factors, such as gaining reputation and signaling expertise were discovered. The third type of extrinsic factor, social motivation, was also cited as one of the motivational factors in open innovation (Schuurman, Baccarne, Marez, & Mechant, 2012). Another factor in this category, the desire to be with similar-minded people, also drove participation in open-innovation communities.

Besides the difference in terms of the intrinsic motivational factors, these motivational factors were also found to differ according to different types of open innovation communities (Simula & Ahola, 2014). Ståhlbröst and Bergvall-Kåreborn (2011) further classified motivation in different open innovation communities, namely: brand community, beta-test community, user content communities, development communities and innovation intermediary communities. The brand community consists of experienced and avid consumers of specific brands like Nike, and they actively participate in product innovation (Füller, Matzler, & Hoppe 2008; Muniz & O'guinn, 2001), while beta-test communities are represented by users who experiment with prototypes and provide feedback before the products are launched. In user-content communities, users collaboratively contribute various types of information as in Google Maps and YouTube. Development communities refer to open-source communities and other developer communities, who develop new IT product or service, such as Linux (Barcellini, Burkhardt, & Détienne, 2008). In innovation-intermediary communities, a neutral third party hosts the community comprising users who are not the companies' customers, and there is no strong relationship between the users and the company (Antikainen, Mäkipää, & Ahonen, 2010a). Table 2 shows the identified motivational factors in each type of innovation community.

Table 2
Classification of motivational factors according to two types of open-innovation communities

Type of Open Innovation Community	Intrinsic		Extrinsic		
	Enjoyment	Passion for Community	Immediate	Signalling Expertise	Social Motivation
Brand Community	Interest innovation (Füller et al., 2008).				
	Learn something new (Ståhlbröst & Bergvall-Kåreborn, 2011)		Win something (Ståhlbröst & Bergvall-Kåreborn, 2011)	Recognition (Füller et al. 2008, Bayus, 2013).	
	Stimulate curiosity (Ståhlbröst & Bergvall-Kåreborn, 2011)				

Table 2 *(continue)*

	Testing innovative products (Ståhlbröst & Bergvall-Kåreborn, 2011)				
Developer Community	Fun and challenging (Antikainen et al., 2010a) Knowledge exchange and learning (Wasko, McLure, & Faraj, 2000) Intellectual simulation (Lakhani & Wolf, 2003)			Reputation building Casalo, Cisneros, Flavián, & Guinaliu, 2009)	
Beta-Test Community	Curiosity (Peltola, 2008)	Altruism (Peltola, 2008) New viewpoint (Antikainen et al., 2010b)	Money or products (Antikainen et al., 2010a)	Being a forerunner (Peltola, 2008) Reputation (Antikainen et al,. 2010a)	Similar people (Antikainen et al., 2010b)
User Content	Enjoyment (Antikainen et al., 2010b)			Status seeking (Lampel & Bhalla, 2007)	
Innovation Intermediary	Learn something new (Ståhlbröst & Bergvall-Kåreborn, 2011, Muhdi et al., 2011) Stimulate curiosity (Ståhlbröst & Bergvall-Kåreborn, 2011) Testing (Ståhlbröst & Bergvall-Kåreborn, 2011) Sense of efficiency (Muhdi et al., 2011)		Win something (Ståhlbröst & Bergvall-Kåreborn, 2011) For a reward. (Antikainen et al., 2010b, Muhdi et al., 2011)	For fame or exposure (Antikainen et al., 2010a) Recognition (Antikainen et al., 2010b)	Social interaction (Antikainen et al., 2010a, Muhdi et al., 2011)

In summary, both intrinsic and extrinsic motivational factors influence participation in diverse open-innovation communities. Most importantly, for creating intrinsic motivation, the crowdsourcing application needs to accommodate tasks or opportunities that can create new knowledge and enhance the sense of efficiency of the participants. Additionally, participants need to be involved in contributing ideas that stimulate their intellectual ability and curiosity. In these open-innovation communities, the participants emphasise on the learning process, experience and the social interaction with like-minded people in addition to monetary rewards.

Challenges in Open-Innovation Communities

The concept of crowdsourcing for ideas, however, imposed several issues that can be categorised in two main challenges: managing the ideas and sustaining the participants of crowdsourcing communities.

In managing the ideas contributed by the communities, the first challenge was to understand the ideas contributed. Most of the organisations implementing crowdsourcing have a difficult time understanding the idea posted due to lack of details about the ideas and lack of understanding among the idea contributors (ideators), other users and the organisation itself (Gangi, Wasko, & Hooker, 2010). The contributors are usually focussed on developing solutions rather than on elaborating on the initial ideas posted by others, and this led to minimal collaboration between them (Majchrzak & Malhotra, 2013). Organisations then faced difficulties in identifying and selecting the best promising ideas due to the large volume of ideas collected and idea duplication. The large volume of ideas overwhelmed the organisations as they needed to evaluate all the ideas contributed, not just the top-ranked ones. Other than managing such an overwhelming quantity of ideas, the quality of the ideas contributed often suffered due to the race to contribute lots of ideas. The race to quickly post the ideas led the contributors to fail to offer good solutions that incorporated various perspectives, risks and needs (Majchrzak & Malhotra, 2013). Apart from the quantity and quality of the ideas contributed, protecting the ideas contributed was also a challenge for the organisation. The organisations faced difficulties in balancing information dissemination to their own contributors against disclosure to their competitors. Protecting ideas contributed is crucial when there are competitors attempting to derive financial benefit from the ideas and creativity mined from crowdsourcing communities (Chanal & Caron-Fasan, 2010).

Sustaining continued contribution from participants of crowdsourcing communities is another issue that needs to be addressed by organisations (Gangi et al., 2010). Apart from managing the ideas contributed, organisations have to develop strategies for interacting with their contributors in order to sustain their participation and idea contribution. This is important as organisations can potentially lose their valuable contributors and their ideas if their contributors feel alienated due to lack of communication and interaction between both parties. Organisations need to protect and nurture the relationship between them and the contributors carefully to effectively ensure sustainable contribution of ideas. On the other hand, less collaboration among the contributors will lead to the failure of ideas to evolve and create solutions for organisations due to diminished willingness among contributors to provide free help when competition increases.

CONCLUSIONS

After analysing and classifying the factors that stimulate crowdsourcing motivation, this study found that factors responsible for intrinsic enjoyment were different from the factors responsible for crowdsourcing for tasks. It was found that in task-based crowdsourcing application, the factors that led to intrinsic enjoyment were mostly associated with the task characteristics and design such as task autonomy and task identity and sense of efficiency, which encapsulates aspects like triggering creativity and innovation, self-development and increasing efficiency. On the contrary, in crowdsourcing for ideas, the factors that led to enjoyment were established from the learning experience, curiosity and intellectual stimulation that resulted from participating in open innovation. In addition, monetary rewards and the desire to win something were the factors that led to immediate extrinsic motivation. However, in crowdsourcing for ideas, other delayed extrinsic motivational factors like gaining reputation and signalling expertise played a significant role. Another extrinsic factor, social motivation, which is the desire to be with like-minded people, was also cited as one of the motivational factors in open-innovation communities.

The motivational factors also differed in proportion to different types of open-innovation communities. This study found that there were different motivational factors in different open-innovation communities, such as brand community, beta-test community, user content communities, development communities and innovation-intermediary communities. It can be summarised that intrinsic and extrinsic motivational factors influence participation in diverse open-innovation communities. Above all, in order to appeal to intrinsic motivation, a crowdsourcing application needs to provide tasks or opportunities that can create new knowledge and enhance the sense of efficiency of the participants.

There are two main challenges in crowdsourcing in open-innovation communities, which are understanding and protecting the contributed ideas and sustaining crowdsourcing participants. Understanding the contributed idea tended to be difficult because of lack of details about the idea and understanding among the parties involved. Protecting contributed ideas was found to be critical when there were competitors attempting to derive financial benefit from the idea and creativity evident in crowdsourcing communities. In addition, it was found that to ensure sustainability of idea contribution, task providers needed to protect and nurture their relationship with the communities.

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The Rise of Crowdsourcing Using Social Media Platforms: Security and Privacy Issues

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ABSTRACT

The increasing adoption of social media is a viable means in crowdsourcing. It can facilitate the connectivity of collaboration between different organisations, people and society to produce innovative and cost-effective solutions to many problems. Social media have opened up unprecedented new possibilities of engaging the public in meaningful ways through crowdsourcing. However, the growing number of security and privacy issues in social media may weaken the efficacy of crowdsourcing. This study aims to provide a basic understanding of security and privacy issues in line with the growth of crowdsourcing using social media platforms. This study also illustrates how crowdsourcing and social media data can lead to security and privacy issues in different environments. Lastly, this study proposes future works that may serve as direction for scholars to explore security and privacy in crowdsourcing through social media platforms. Secondary sources obtained from journals, conference papers, industry reports and books were reviewed to gather information.

Keywords: Crowdsourcing, privacy, security, social media

INTRODUCTION

The term 'crowdsourcing' is becoming well known among organisations in various fields as well as the interdisciplinary research community. Howe (2006) coined the term by combining the words 'crowd' and 'outsourcing'. This study uses the definition of crowdsourcing by Halder (2014a, pp377-393) as "the process of finding needed information and service for a common goal from a large number of people." Over the last few years, types of crowdsourcing have expanded rapidly, allowing people to connect with one another through crowd voting, crowd creation, crowd wisdom and crowd funding.

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In recent years, social media have become ubiquitous and important in social networking as well as content sharing. Social media, such as social networking, media sharing, blogging and tweeting, have been used worldwide as an important tool for communication (Rahim, Ismail, & Samy, 2014). Social media also act as an intermediate platform for raising support. By establishing relationships, social media manage to create value with the participation of its users. People connect with one another based on the values that they share. Both crowdsourcing and social media owe their presence to the influence of networks. When different individuals perform a specific common task, the output may vary from one to another. However, when people come together to work towards a common goal, great outcomes can be achieved.

Crowdsourcing rides on this wave of creativity, empathy and support that combines the contributions from a crowd of people to build completely new ventures and sharply radical ideas. For example, crowdsourcing can take the smallest ripple in marketing and form great waves of ideas that result in new ways of thinking by democratising the process of starting and running a business. The power of crowds makes any ambitious concept become possible. Social media help to spread the word about crowdsourcing projects and reach out to intended users who might be able to contribute meaningfully towards a new project.

The use of crowdsourcing in different domains not only makes it possible to mine, aggregate and categorise data but also helps in the readiness to face a certain situation, reaction during the situation and recovery after the situation (Halder, 2014a). However, the increasing usage of crowdsourcing in social media has also given rise to certain issues and challenges. This study investigates security and privacy issues related to crowdsourcing activities that use social media. The first section of this paper introduces crowdsourcing usage in social media platforms. The second section reviews the various usage of crowdsourcing in social media platforms. The third section describes the methodology used to achieve the aim of this study. The fourth section discusses the security and privacy issues related to crowdsourcing in social media. Finally, the conclusion summarises the output of this study.

Crowdsourcing Usage in Social Media Platforms

Social media platforms are believed to be one of the most influential sources in capturing the latest information involving many participants in crowdsourcing. 'YouPartTime' and 'MyTeksi' are examples of crowdsourcing platforms that are linked to social media in Malaysia for searching for part-time jobs and taxi booking (Habbal et al., 2015). In this section, before identifying the security and privacy issues, some aspects of crowdsourcing in social media will be briefly described. Some crowdsourcing activities that utilise social media platforms are disaster relief, facial attributes and depression prediction.

Disaster Relief

One of the crowdsourcing activities that use social media is disaster relief. People are able to report and update latest information on disasters that may happen or have already happened for immediate response. Data analysis and collection relating to the disaster can also be conducted. From a few cases involving catastrophic earthquakes in Haiti, Afghanistan, Kenya and Mexico, a crowdsourcing tool known as 'Ushahidi' (www.ushahidi.com), for instance, was

able to gather latest information from multiple sources including social media (Gao, Barbier, & Goolsby, 2011). Previously, Zook, Graham, Shelton and Gorman (2010) demonstrated that different types of crowdsourcing information and mapping services can greatly enhance the logistical systems upon which relief efforts are ultimately grounded.

Another crowdsourcing tool involving social media is called 'Tweak the Tweet', which uses the Twitter platform for updating crowdsourced information during mass emergencies (Starbird & Palen, 2011). This tool even provides rewards for the participants involved in reporting any related incidents. An open-source web platform developed by Rogstadius et al. (2013) known as 'CrisisTracker' is able to track keywords on Twitter and construct stories by clustering related tweets from lexical similarity to promote disaster awareness. The Crowdsourcing Disaster Support platform (CDSP) developed by Yang et al. (2014) is able to provide real-time assistance that extracts input from social networks, learning from the past and historical data for instant communication services.

Facial Attributes. Crowdsourcing in social media also contributes facial attributes that provide information about a person based on the communities' uploaded images and video collections. Facial attributes can be detected from leveraging photos in social media and removing 'noisy photos' by mid-level feature voting from crowdsourcing methods (Chen, Hsu, & Liao, 2011). Not only that, facial expression and the affect recognition system that utilises crowdsourcing methods gather information from videos uploaded online and are able to view natural and spontaneous responses over the web (McDuff, El Kaliouby, & Picard, 2011).

Predicting Depression. Social media platforms are also crowdsourcing tools for identifying depression among users based on the postings. De Choudhury, Gamon, Counts and Horvitz (2013) examined the ability of image postings on Twitter that can be used to measure and predict depression among individuals with 70% accuracy. In another study by Nadeem, Horn and Coppersmith (2016), crowdsourcing platforms were employed to compile a list of Twitter users who had professed to being diagnosed with depression. They successfully demonstrated the potential of using Twitter as a tool for measuring and predicting major depressive disorders in individuals. The ability to estimate, generalise and interpret daily variations in depression may be used in a medical context to identify clinical depression from the behaviour of social media users. The potential in identifying depression prior to the onset of mild depression can also help save lives.

METHOD

The review of security and privacy issues of crowdsourcing in social media platforms was based on secondary sources. The information obtained from journals, conference papers, industry reports and books was summarised to develop understanding on security and privacy issues. The online databases that were given particular attention include Springer Link, Science Direct, Emerald Library, IEEE Explorer Digital Library, Taylor & Francis Online and EBSCO host. Search terms were used to find relevant articles included crowdsourcing, social media, security and privacy. The inclusion criteria for the articles were predetermined to be: 1)

Articles published in English, 2) Full-text articles, and 3) Security or privacy issues related to crowdsourcing in social media platforms. Because of the limited number of literature found, this study looked at the basic understanding of security and privacy that has been previously discussed and the issues that society may face as crowdsourcing in social media continues to grow.

Security and Privacy Issues

Crowdsourcing can bring additional risks since these services are often outsourced or indirectly managed. With the increasing number of crowdsourcing activities available through social media, participants are exposed to security and privacy issues. In the next section, the security issues discussed pertain to data security, confidentiality and integrity, while privacy issues focus on privacy violations, identifiable information and information sharing.

Security Issues

The use of crowdsourcing platforms through social media has become one of the main choices by organisations for providing services. However, using social media as a platform may expose users to a few security issues. Information security makes use of some measurement in order to protect information supported to crowdsourcing platforms (Cilliers & Flowerday, 2015).

Data security. With the increasing usage of crowdsourcing in many different forms, many organisations may be able to virtually spy on political persons (Halder, 2014b). Rapid use of mobile applications for crowdsourcing activities may expose users to security issues. This includes revealing location information involving mobile movement and also personal data stored in mobile devices. The availability of such data through crowdsourcing platforms that use social media can lead to a rise in illegal activities engineered by cybercriminals (Shiffman & Gupta, 2013). For example, if a cybercriminal is able to spoof one identity, he or she would be able to gain access to many accounts such as personal email, bank or health records.

Individuals may have malicious intent towards the goal, sponsoring organisation or individuals, individual participants or underlying infrastructure in a crowdsourcing solution. The anonymous data stored from different sources in social media may endanger consumer data, thus violating data security regulations (Wolfson & Lease, 2011). Hence, legal issues related to data security must be addressed in order to avoid misuse of personal information that will further lead to other issues. With the open-call format concept of crowdsourcing, conflict of data between participants in crowdsourcing platforms and crowd developers may also lead to intellectual property issues (Simula, Töllmen, & Karjaluoto, 2015).

Confidentiality. Confidentiality is related to data security and is associated with ensuring information exposed in social media will not be misused in the crowdsourcing platform. An example of security risks reported on sensitive data exposure is the Netflix cases. Netflix is a type of social media that provides video content delivery services and has being sued by consumers for illegal use of consumer data (Lieberstein, Tucker, & Yankovsky, 2012).

However, Sarwar and Khan (2013) stated that once a citizen has posted information on a crowdsourcing platform, the ownership of the data is no longer that of the citizen. This shows that the confidentiality of data has not being secured appropriately in crowdsourcing platforms. This increases the chances of identity theft among consumers. Therefore, there is a need for a security policy that can protect information belonging to participants of crowdsourcing. Lease et al. (2013) identified Amazon's Mechanical Turk as one of the powerful crowdsourcing tools that have claimed that online work is anonymous but sensitive information regarding participants can be revealed.

Integrity. Users were also concerned about the integrity of the data gathered in crowdsourcing platforms. Since the data from social media can be in any form, it has been reported that users were very concerned about modification of stored information (Cilliers & Flowerday, 2015). Hence, there should be administrative control of the crowdsourcing platform that is able to ensure data integrity and accuracy posted through social media (Barbier, Zafarani, Gao, Fung, & Liu, 2012). For example, using crowdsourcing platforms in the medical environment requires accuracy for the data collected. Therefore, it is very important that the integrity of the data posted through the crowdsourcing platform be maintained to ensure that the crowd are receiving correct information.

Privacy Issues. Social media can be a powerful tool for influencing and educating (Jean Barry MSN, 2012). However, the emergence of various social media sites has changed the perception of privacy (Halder, 2014b). Furthermore, it may also potentially impact negatively on professionalism, ethics and privacy in some professions (Rahim, Ismail, & Samy, 2014). Using crowdsourcing in the social media platform may also potentially pose a threat to the privacy and protection of the users' personal and sensitive data.

Privacy violations. As the popularity of crowdsourcing escalates, the rate of 'crowd attacking' will also grow. Important information providers are being attacked both physically and virtually. Massive data including status updates, personal thoughts about certain issues or ideas, also known as 'crowdsourced information' or 'user generated content', are also unprotected. For example, governments and others parties are able to virtually spy on any person if they wish to.

Detailed information about individuals, mobile numbers, IP addresses and geographical locations can be violated as masses of data are easily collected through social media platforms (Halder, 2014a). Different types of information are being collected through crowdsourcing that may lead to identity profiling, where health status, age, gender, race, religion, political ideology, sexual orientation and other details of individuals can be guessed. Thus, the information providers of crowdsourcing can become potential victims of privacy violation.

Identifiable Information. Geography tagging has become a popular feature on several social media platforms, such as Facebook and Instagram. It is also known as geo-tagging, referring to a process of adding geographical identification on the online post. Facebook users can geo-tag photos that can be added to the page of the location where the picture is tagged. Users

may use this feature to find nearby Facebook friends by spawning a list of people based on the location tracker in their mobile devices. Instagram uses a map feature that allows users to geo-tag photos, thus allowing users to link specific photos on a world map.

This shared geo-tag information may also contribute to negative impact with regards to privacy (Huang & Gartner, 2016). For instance, there is a possibility of accidentally revealing a home address when a photo has been geo-tagged in front of a home. Any geo-tagged photo that reveals a school logo may possibly expose the location of the school to potential child-crime offenders. Such geo-tagged photos or information can reveal personal information, and this can cause harm if the information falls into the wrong hands.

Information Sharing. Today, people share sensitive information about themselves on social media to obtain feedback from virtual community members (Denecke et al., 2015). For instance, Facebook users openly sought and shared information relating to behavioural, mental and genetic health by publicly revealing their name, photo and location when seeking sensitive health information using social media (Househ, 2011). Another example is when parents share their child's health information along with pictures online, before a public audience, as happened on CrowdMed (Denecke et al., 2015).

The purpose of information sharing is possibly to exchange information and share experience. At the same time, users can seek emotional support and request guidance and advice from healthcare professionals and others via social media. Through crowdsourcing using social media platforms, patients can ask for a second or third opinion of a diagnosis or treatment (CrowdMed, 2010). However, online interaction with patients may pose risks because of the uncertainty related with the written language, which may not represent the actual context of body language or the lack of awareness of potential abuse with regards to social media data (Chretien & Kind, 2013). These risks might lead to a wrong diagnosis or treatment suggestion and even place the individual in danger.

Therefore, there is a need to look into matters concerning privacy with regards to using social media. Privacy breaches may cause great harm when they occur online. This is because social media can potentially be accessed even globally because of the nature of digital information. More research should be done to develop privacy-preserving techniques for crowdsourcing and social media data analysis. The ethical issues concerning methods of sharing information, obtaining consent and using information for research or commercial purposes should be the primary concern in protecting the privacy of individuals who use social media platforms.

Table 1 summarises security and privacy issues of crowdsourcing using social media platforms that have been discussed in previous sections.

Table 1
Summary of security and privacy issues of crowdsourcing using social media platforms

Issues	Details	References
Security		
• Data Security	Anonymous data stored from different sources in social media may endanger consumer, thus violating data security regulations.	Shiffman and Gupta, 2013; Simula, Töllmen, & Karjaluoto, 2015
• Confidentiality	Sensitive information related to individuals or organisations might be exposed in social media.	Lieberstein, Tucker, & Yankovsky, 2012; Sarwar and Khan, 2013
• Integrity	Maintaining the integrity of the data posted ensures that the crowd receive correct information.	Cilliers and Flowerday, 2015
Privacy		
• Privacy Violations	Collected information may violate privacy of individuals or organisations.	Halder, 2014a.
• Identifiable Information	Personal information, which can lead to harm if it falls into the wrong hands, can be revealed.	Huang and Gartner, 2016
• Information Sharing	Collected information may not represent the actual situation and the possibility of abuse of social media data might lead to wrong perceptions.	Househ, 2011; Denecke et al., 2015; CrowdMed, 2010

CONCLUSION

Security and privacy are important matters to consider in crowdsourcing. As the use of crowdsourcing in many platforms increases, initiative should be taken to develop the guarantee of security and privacy in crowdsourcing from an ethical, legal and technological context. Three security issues were discussed in this study: data security, confidentiality and integrity. In addition, three privacy issues were reviewed: privacy violations, identifiable information and information sharing. The review highlighted key issues pertaining to crowdsourcing using social media platforms. This review provides useful information and knowledge, highlighting both security and privacy as crucial issues in crowdsourcing using social media platforms. Due to the limited number of security and privacy studies on crowdsourcing, this study was only able to refer to few studies available in the literature on social media platforms. Extensive literature is needed to accurately assess existing crowdsourcing tools to gauge the level of current security and privacy in this area. Therefore, further research in various fields is needed to investigate appropriate mechanisms to ensure the security and privacy of users of crowdsourcing using social media platforms.

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Conceptual Model for a Sustainable Crowdsourcing Ecosystem

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ABSTRACT

Crowdsourcing has changed the way people conduct business. It provides access to work, and employers can source for the best talent, at the best price, with the shortest turnaround time. Research so far has focussed on crowdsourcing implementation. Hence, there is a need to conduct research that can contribute towards crowdsourcing sustainability. Thus, the objectives of this paper are to identify current practices of crowdsourcing in Malaysia and the challenges that face it. A conceptual model for crowdsourcing sustainability ecosystem is then proposed. This study adopted the case-study approach. Two crowdsourcing platforms were examined in the case study. Two techniques were used to obtain the data: observation and interview. Observation was carried out to observe how the crowdsourcing platforms worked. The interviews helped to uncover current practices, challenges in using crowdsourcing and identification of sustainability factors. It is hoped that the proposed conceptual model will facilitate better planning of the ecosystem supporting crowdsourcing and ensure sustainable growth for crowdsourcing. Future research into crowdsourcing can test the proposed conceptual model to validate its components.

Keywords: Crowdworkers, ecosystem, job provider, platform, sustainable model

INTRODUCTION

Jeff Howe is among the first authors who described crowdsourcing. Howe (2006) described crowdsourcing as the art 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. Brabham (2008) defined crowdsourcing as the collective intelligence of the public to develop skill sets or a larger workforce to achieve a specific goal. It offers several benefits to its key

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players such as low cost (Schenk & Guittard, 2011), bridge income gap, enhanced quality of life, and improved the quality of human capital (MDeC, 2012).

Research into crowdsourcing so far has concentrated on practices (Aris, Janom, Arshad, Salleh, & Mastuki, 2013). Due to its benefits, it is important to ensure that the ecosystem supporting crowdsourcing is sustained. Therefore, it was felt that a study on the sustainability of the ecosystem that supports crowdsourcing was needed. The first section of this paper introduces crowdsourcing. It is followed by a look at the background of crowdsourcing and the concepts surrounding it as well as the issues and challenges facing its sustainability. Methodology is then discussed, followed by a presentation and discussion of the results. In this part, a conceptual model for a sustainable crowdsourcing ecosystem will be introduced and discussed.

Crowdsourcing

Crowdsourcing is defined as the act of a company or institution taking a function once performed by employees and outsourcing it to an undefined and generally large network of people in the form of an open call (Howe, 2006). Freitas, Calado, Braga, Silva and Dias (2010) refer to crowdsourcing to illustrate the power of huge numbers of people to reach a specific goal in collaborative method over the Internet. Meanwhile, Hobfeld, Hirth and Tran-Gia (2011) defined crowdsourcing as the activity of outsourcing a job to a large, anonymous crowd of workers, the so-called human cloud, in the form of an open call.

Crowdsourcing consists of three key players (Arshad, Salleh, Janom, Aris & Mastuki, 2012). As shown in Figure 1, the three key players are job providers, platforms and crowdworkers. Job providers provide jobs on crowdsourcing platforms. The platforms facilitate the work process such as hiring, collaboration or bringing together of jobs. Crowdsourcing platform owners in Malaysia include Human Capital Connection Sdn, Bhd, PERNEC Corporation Bhd., Ikrar Potensi Sdn. Bhd. and Multimedia Synergy Corporation Sdn. Bhd. Crowdworkers are groups or pools of individuals who are qualified to complete certain tasks in a specific employment situation (Hirschheim, 2012).

Figure 1 shows the business process of crowdsourcing. Job providers submit tasks or jobs to crowdsourcing platforms. The platforms then advertise the jobs via their marketplace, email or SMS notification. Crowdworkers respond to, or "pull" jobs that suit their skills and capabilities from the crowdsourcing platforms. Once the jobs are completed, job providers check the quality of the work. Once approved, the crowdworkers will be paid.

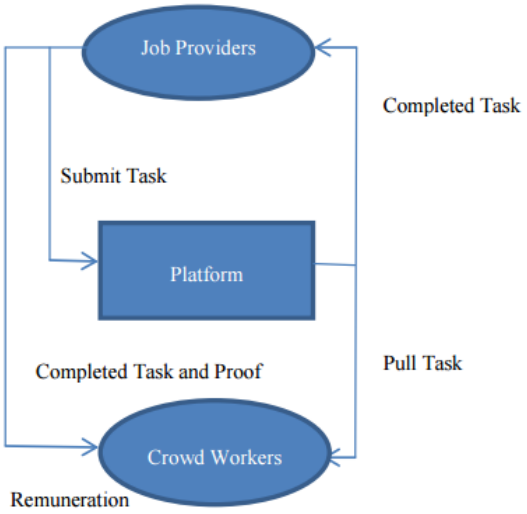

Figure 1. Crowdsourcing business model
Source: Arshad, Salleh, Janom, Aris, & Mastuki (2012)

Issues and Challenges for Crowdsourcing Sustainability

Crowdsourcing faces several issues that need to be addressed. Security, privacy, quality and trust are among the issues highlighted in crowdsourcing implementation (Obal, 2009). The key players in the crowdsourcing ecosystem are concerned about security and privacy, that is, how are they to provide enough information to crowdworkers, but at the same time ensure their privacy is not breached. Meanwhile, lack of experience and skill may lead to low-quality work submitted by crowdworkers. This will affect the product or output requirements set by the job provider (Arshad, Salleh, Aris, Janom, & Mastuki, 2013).

Another challenge in crowdsourcing implementation is a weak payment mechanism (Arshad, Salleh, Janom, Aris, & Mastuki, 2012). Where the job provider directly pays crowdworkers, the concern among crowdworkers is that they will not be paid after the jobs are completed; this touches on trusting the crowdsourcing ecosystem and its credibility.

International crowdsourcing platforms also seem to be dominating the crowdsourcing industry. This leads to competition between local platforms and international platforms. Since international platforms may not be able to provide the supply for the local market, the capability of local platforms to serve the local market needs to be highlighted. An attractive and competitive platform is needed for the sustainability of crowdsourcing (Arshad, Salleh, Janom, Aris, & Mastuki, 2012). It is important for local crowdsourcing platforms to be attractive and competitive.

Malaysia has the resources to stimulate the crowdsourcing ecosystem. Malaysia has a huge latent workforce able to become crowdworkers. About 92% of Malaysian adults are able to speak English, Malay, Chinese, Tamil and Arabic language abilities (MDeC, 2012). Last but not least, Malaysia has good infrastructure for Internet connectivity and most Malaysians own a mobile phone (MDeC, 2012). It is hoped that the key players in the crowdsourcing ecosystem can fully utilise these resources so that the crowdsourcing ecosystem can be sustained.

METHOD

This research was carried out using the case-study approach. Two organisations participated in the case study. They were selected because they are among the credible crowdsourcing platform owners in Malaysia. Two techniques were used for data gathering i.e. observation and interview. Observation is a useful method because it allows researchers to determine who interacts with whom and to grasp how participants communicate with one another (Schmuck, 1997). The purpose of observation in this research was to observe the working environment and to obtain data on current crowdsourcing practices. Observation was conducted at the premise of the crowdsourcing platform owner.

The interview technique was used to study the challenges facing crowdsourcing implementation and the factors that contribute to a sustainable crowdsourcing ecosystem. Organisation A was represented by its Chief Executive Officer (CEO). This platform focusses on data entry and developing skills and talent of crowdworkers. Meanwhile, Organisation B was represented by their IT Personal Consultancy. The platform focusses on training and supplies jobs for crowdworkers. The interviews were conducted face-to-face in two separate sessions. Each session took up almost one and a half hours. The interviews were conducted at the platform owners' premise. Each session was recorded and then transcribed for analysis.

The data from the interview sessions were then analysed using the content analysis technique to yield the factors that lead to a sustainable crowdsourcing ecosystem. A conceptual model for a sustainable crowdsourcing ecosystem was then proposed.

RESULTS AND DISCUSSIONS

This section first presents the current practices of crowdsourcing platforms, the challenges faced in crowdsourcing implementation and the factors necessary for a sustainable crowdsourcing ecosystem. Following that is a discussion of a conceptual model for a sustainable crowdsourcing ecosystem.

Current Practices of Crowdsourcing Platforms

Organisation A offers digital and non-digital work for their crowdworkers, while Organisation B offers only non-digital work for their crowdworkers. In terms of advertisement, Organisation A has a system that is used to advertise jobs. Crowdworkers need to create an account and log in to view available jobs. Besides that, the organisation also advertises jobs using email. Organisation B, on the other hand, advertises jobs only via email. Both organisations do not require crowdworkers to have academic qualification to perform the jobs. Anyone can pull jobs as long as he or she has the skills required to complete them. Some of the jobs offered require specific skills. In this case, these platforms help the crowdworkers by providing relevant training in order to complete the jobs.

In order to ensure the jobs submitted by crowdworkers conform to acceptable quality and standard, job validation is done by the job providers. In addition, Organisation A also requests that job providers be clear about their requirements and the standard expected from

responding crowdworkers. Apart from that, Organisation A also provides a star rating for their crowdworkers as one way to profile their experience and performance.

Challenges in Crowdsourcing Implementation

The results of the interviews revealed several challenges in crowdsourcing implementation:

i. Limited number of jobs available: This is due to the limited number of organisations (job providers) who are willing to participate in crowdsourcing. Their concerns are confidentiality of data if jobs are completed by an unknown crowd.

ii. Limited number of crowdworkers: It can be difficult attracting participation in crowdsourcing due to several reasons such as trust, security, privacy and payment. A small number of crowdworkers pose challenges for the platform in continuing their operation.

iii. Lack of relevant skills among crowdworkers: Most of the jobs in crowdsourcing do not require academic qualification. Instead, they require crowdworkers to possess certain skills relevant to the jobs. Some crowdworkers do not have the avenue to upgrade their skills, thus they may not be able to accept the jobs offered.

iv. Perception of crowdworkers towards job providers and platforms: Lack of trust in job providers and crowdsourcing platforms makes it difficult to sustain the crowdsourcing ecosystem. Crowdworkers are afraid they are dealing with bogus job providers and that offers are part of a scam.

v. Security of payment mechanism: The crowdsourcing platforms should establish a mechanism to ensure they can protect both parties, the job providers and the crowdworkers. Job providers are afraid they are paying for non-quality work, while crowdworkers are worried about not getting paid.

All the challenges identified can thwart the growth of crowdsourcing. Thus, it is important to resolve these issues to ensure that crowdsourcing can be sustained.

Factors for a Sustainable Crowdsourcing Ecosystem. Based on the case study, several factors were identified as sustainable factors for crowdsourcing implementation, as discussed below.

i. Continuous quality improvement: Quality is a very important issue in the crowdsourcing ecosystem. Both organisations take the issue of quality seriously. Organisation A allows job providers to rate the job performance of crowdworkers. The higher the star rating, the more reliable the crowdworkers are. It shows that they have been continuously providing jobs with good quality. Meanwhile, Organisation B protects quality by filtering the crowdworkers and ensuring only suitable candidates perform the job. The way the organisations manage the issue of quality ensures the sustainability of a crowdsourcing ecosystem.

ii. Trust: Crowdworkers are concerned that the information provided to the crowdsourcing platforms will be misused. Therefore, both organisations provide assurance in their terms and conditions that specify the information given by the crowdworkers will be protected.

Another concern is that the job providers may be criminally minded, involved in scams and are offering bogus jobs. To prevent such issues, Organisation A fully scrutinises each job provider to make sure it is reliable.

iii. Regulating job providers: In order to sustain the crowdsourcing ecosystem, it is important to regulate job providers. Organisation B emphasises this practice by offering partnerships to job providers.

iv. Jobs availability: It is important to ensure that jobs in a crowdsourcing ecosystem are always available. Job availability will attract more crowdworkers to participate in crowdsourcing.

v. Continuous platform improvement: Organisation A started as a platform without any system to help it; everything was done manually. Currently, it has a system that can help it to advertise jobs, profiling the crowdworkers' database and online payment. They also use a star-rating system. They admitted that continuous platform improvement is an important element for sustaining the crowdsourcing ecosystem.

vi. Effective business procedure. Organisation A admitted that they started their business without any standard business process. Over time, a standard business procedure was introduced, leading to a better working environment. Thus, the introduction of an effective business procedure can lead to a sustainable crowdsourcing ecosystem.

vii. Collaborative platform: Organisation A mentioned that sometimes, some of the jobs could not be completed by their crowdworkers. Therefore, they needed to collaborate with other platforms to ensure they can continuously provide jobs to crowdworkers and at the same time ensure that jobs from the job providers are completed.

viii. Reliable payment mechanism: There should be mechanism to protect both job providers and crowdworkers from any loss. Both organisations use the escrow fund. Through this mechanism, crowdsourcing platforms can guarantee protection for both job providers and crowdworkers. This factor can contribute to maintaining a sustainable crowdsourcing ecosystem.

ix. Crowdworker availability: In ability to establish a sustainable ecosystem for crowdsourcing, the availability of crowdworkers is a must. Therefore, both organisations work hard to attract more crowdworkers.

x. Continuous crowdworker improvement: From time to time, both organisations train their crowdworkers to prepare them for upcoming jobs. Crowdworkers should continuously upgrade their skills and competency level. Upgrading skills and competency level allows crowdworkers to continue receiving jobs from job providers, thus leading to a sustainable crowdsourcing ecosystem.

Conceptual Model for a Sustainable Crowdsourcing Ecosystem. As shown in Figure 2, the Conceptual Model for a Sustainable Crowdsourcing Ecosystem can be divided into two sections: the foundation and the pillars. The foundation layer consists of the elements of trust and continuous quality improvement. The three pillars for a sustainable crowdsourcing ecosystem are the key players in the crowdsourcing ecosystem: job providers, platforms and crowdworkers.

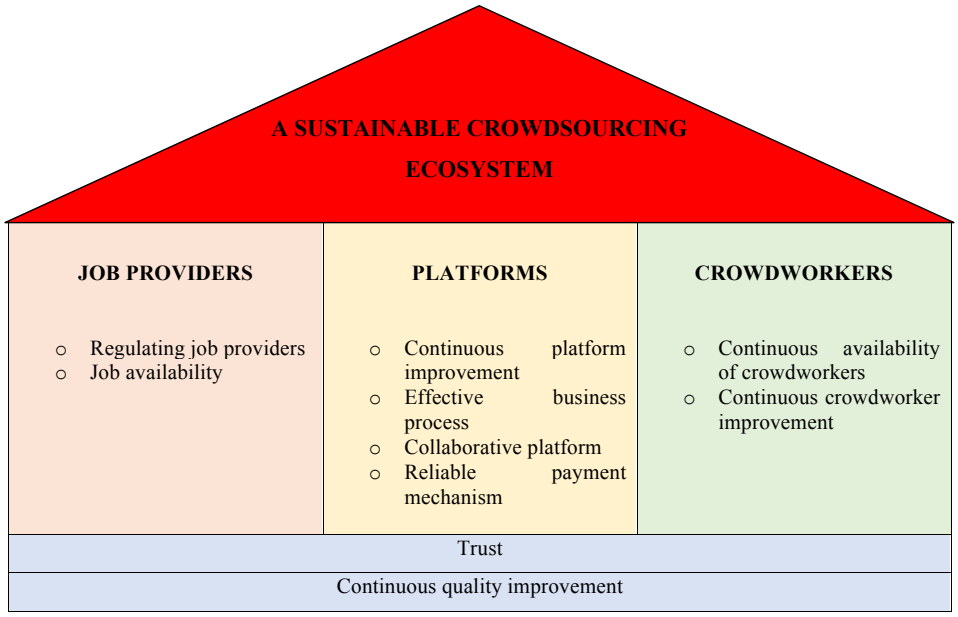

Figure 2. Conceptual model for a sustainable crowdsourcing ecosystem

Continuous Quality Improvement. Continuous quality improvement is considered a foundation for a sustainable crowdsourcing ecosystem because it requires cooperation and involvement from all the key players. Job providers must be responsible to provide sufficient information to crowdworkers so that the jobs can be completed according to the requested quality and standard. Crowdworkers need to execute the jobs accordingly. Crowdsourcing platforms need to oversee the aspects of quality required by job providers and seen in work submitted by crowdworkers, and at the same time, ensure that they are providing the best service to both job providers and crowdworkers. A continuous quality improvement model should be introduced to drive continuous improvement of the ecosystem. Through continuous improvement, all the key players are involved in an ongoing effort to improve the quality of service and processes in a crowdsourcing ecosystem.

Trust. Trust is also a foundation in this model. Crowdworkers are concerned about the security of their personal data and payment. They are afraid that the platforms will misuse and abuse the information that has been provided. Meanwhile, job providers are worry about the confidentiality of their data. Therefore, all key players should take actions to inculcate trust in the ecosystem. Increasing the security and reliability of the crowdsourcing ecosystem will build the trust of the crowdworkers in the system. In terms of security, the platforms should make sure that the payment mechanism is safe. They should also ensure that the personal data provided by the crowdworkers and confidential data provided by job providers are handled properly. In terms of reliability, job providers should be regulated to make sure they are not bogus entities or involved in scams. Reliability of the platform, payment mechanism and job

providers will increase trust and attract more crowdworkers to the ecosystem, thus guaranteeing its sustainability.

Regulating job providers. Job providers could be from any organisation regardless of size. They can also be individuals. Thus, there is a need to regulate job providers. Regulating job providers can solve issues such as bogus and scam jobs. Regulating can also increase the credibility of the crowdsourcing ecosystem in Malaysia.

Job availability. Job availability will help to sustain the crowdsourcing ecosystem as it ensures sufficient amount of work. There is a need to promote crowdsourcing among job providers to ensure sustainable jobs. One of the challenges identified is data confidentiality. Therefore, it is imperative to convince job providers that their data will be treated with confidentiality.

Continuous platform improvement. Crowdsourcing platform owners should continuously upgrade their service to accommodate latest technology in providing services to crowdworkers. In the digital era, platforms should embrace the latest technology to reach potential crowdworkers. To create a sustainable ecosystem, platforms should provide a mechanism where job providers and crowdworkers are able to offer feedback for continuous improvement. This can be done via a star-rating system, for example. A star-rating system allows job providers to provide a rating for crowdworkers' job performance. Other job providers can use the rating to gauge the crowdworkers' performance. It also allows them an idea of the crowdworkers' experience. This mechanism allows job providers to assess the crowdworkers' background before they hand them any task.

Effective business process. The establishment of a business process is crucial in operating crowdsourcing. It ensures that the quality of the service provided to job providers and crowdworkers is continuously maintained; the platforms can continuously receive jobs from job providers and crowdworkers can continuously pull jobs.

Collaborative platform. A collaborative platform can ensure that platforms work together to provide reliable service to job providers. Crowdworkers can also look for jobs available on other platforms if the platforms they had registered in do not provide any relevant jobs.

Reliable payment mechanism. A major concern of crowdworkers is that payment might not be made after a job is completed, while job providers are concerned that the quality of the job may not be worth payment. To protect both parties from any loss, a reliable payment mechanism is required. This factor will certainly contribute to a sustainable crowdsourcing ecosystem.

Availability of crowdworkers. For sustainable crowdsourcing, the availability of crowdworkers is a must. Platform owners should make an effort to attract more crowdworkers. From time to time, crowdworkers should also be trained to upgrade their skills to equip them for upcoming jobs.

Continuous crowdworker improvement. Other than continuously upgrading the platform, platform owners should help crowdworkers to continuously upgrade their skills and competency level. Since some platforms are specialised, owners of these platforms can provide training to their crowdworkers. Upgrading skills and competency levels allows crowdworkers to continuously receive jobs from job providers, thus the crowdsourcing ecosystem is sustained.

CONCLUSION

Crowdsourcing is accepted as a business model that can help crowdworkers to generate income. Since its conception, issues and challenges faced by the key players in the crowdsourcing ecosystem have been noted. Nevertheless, crowdsourcing is here to stay. Thus, it is important to identify the factors that can lead to its sustainability.

This study adopted the case-study approach. Two established crowdsourcing platforms were involved in the case study. Two techniques were used to gather data: observation and interview. The results presented current practices of crowdsourcing implementation in Malaysia and the challenges faced by this new field as well as the factors for establishing a sustainable crowdsourcing ecosystem. A model for a sustainable crowdsourcing ecosystem was proposed consisting of a foundation for crowdsourcing sustainability encompassing continuous quality improvement and trust. The model rests on three pillars, the three key players in a crowdsourcing ecosystem i.e. job providers, platforms and crowdworkers. Factors leading to sustainability of a crowdsourcing ecosystem that are related to job providers are regulating job providers and job availability. Those related to platforms are continuous platform improvement, effective business procedure, collaborative platforms and reliable payment mechanism. Finally, those related to crowdworkers are continuous crowdworker availability and continuous crowdworker improvement. With the proposed conceptual model, it is hoped that the relevant key players can take progressive actions to ensure that the crowdsourcing ecosystem is sustained. For future research, it is recommended that the proposed model be tested to measure its validity.

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Interlinked Motivation Model to Use Mobile Crowdsourcing Platforms Among Low-Income Citizens

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ABSTRACT

Crowdsourcing is an initiative implemented by the Malaysian government to support its National Key Result Area (NKRA) agenda to improve the lives of citizens with low household income in the B40 group. Crowdsourcing activities are done on mobile crowdsourcing platforms that enable workers to perform micro tasks at any time for a fixed payment. However, without active and constant participation from the crowd, this initiative might not be successful. This paper describes a preliminary study in identifying motivation factors for participating in mobile crowdsourcing platforms. This study identified intrinsic and extrinsic motivation factors that can attract crowds to participate in mobile crowdsourcing platforms. Technology efficacy factors that interlink with motivation factors were also identified in this study. The preliminary study employed the qualitative method where in-depth interviews were conducted among 30 crowdsourcing participants in Peninsular Malaysia. The findings of this study are the basis for a motivation model that can attract crowdworkers from among the B40 group of household-income earners to participate in crowdsourcing to procure and perform available micro-tasks. The findings will also help improvise mobile platforms for crowdsourcing.

Keywords: Crowdsourcing, interlinked motivation model, mobile crowdsourcing platform

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INTRODUCTION

Crowdsourcing is being widely used by companies and organisations to help them improve their operation and management process. Following the evolution of crowdsourcing, crowdsourcing platforms have been implemented to attract communities to register as crowdworkers to perform jobs and tasks made available on crowdsourcing platforms by job providers. Crowdsourcing is an alternative means undertaken by various

industries of securing workers for jobs and tasks with the benefit of faster completion of jobs. According to Lieberstein, Tucker and Yankovsky (2012), crowdsourcing is the act of taking a job from a job provider and outsourcing it to unknown parties sourced from a large group of workers through open calls. The act of outsourcing jobs or tasks to an undefined group of crowdworkers is a potential problem-solving tool both for the profit and non-profit sectors Brabham (2008).

Crowdsourcing has four components: crowdworkers, crowdsourcing platform, crowdsourcing task and crowdsourcer or job provider. Crowdworkers are the group of workers who perform tasks needed to be completed by job providers. They go through lists of jobs on a crowdsourcing platform to search for suitable tasks that match their qualification and skill. The main reason for the participation of the crowdworkers in performing a task is to increase their income (Molina Romo, 2014). The crowdsourcing platform is a website that works as a medium for enabling job matching and hiring workers. Most job providers interact directly with a crowdsourcing platform to advertise their tasks. Typical crowdsourcing tasks are translation, transcription, data entry and validation, research, report writing and image tagging. These tasks have to be completed in a specific time as requested by the job provider. Job providers are agencies or individuals who provide tasks for the crowd. They usually outsource tasks in order to improve their operation, management or business.

The success of completing a job or task provided by job providers depends on how crowdworkers deliver their skills and abilities. The quality of the task performed by crowdworkers depends on the reason for crowd participation. Some workers are motivated to work and participate in crowdsourcing activities because of the payment offered and they ensure that the task is completed. However, the quality of the task cannot be guaranteed (Rogstadius et al., 2011). For low-income earners, crowdsourcing generates extra income (Schmilinsky, n. d.), while other crowdworkers might be participating in crowdsourcing activities for personal satisfaction. These reasons, self-satisfaction and income generation, are referred to as intrinsic and extrinsic motivation for participation in crowdsourcing activities.

Other than helping to reduce workload, crowdsourcing helps to generate income for lower-income citizens, especially those among the B40 group whose income per month is below RM4000. Addressing the research gap in crowdsourcing is essential especially with the launch of the crowdsourcing initiative for Malaysia under Digital Malaysia, which is led by the Multimedia Development Corporation (MDeC). In October 2014, eRezeki was introduced (eRezeki Programme, 2015) as a digital programme to help the B40 group generate income. Some crowdsourcing platforms such as Amazon Mechanical Turk have a large number of crowdworkers. This encouraged the Malaysian government to make crowdsourcing one of the initiatives in Malaysia's National Key Result Areas (NKRA) and led it to collaborate with MDeC to develop eRezeki, which is located in almost all states in Malaysia. However, MDeC is currently facing challenges attracting workers to crowdsourcing platforms. According to Badlisham Ghazali, MDeC's Chief Executive Officer, introducing crowdsourcing in Malaysia is seeing "more challenges than anything else." Some of the tasks made available come with payment but some do not, and this curbed crowd interest in taking up tasks.

In order for crowdsourcing to become a credible option among job seekers in Malaysia, the factors that can motivate their participation in crowdsourcing need to be identified.

Motivation Model

A motivation model for crowdsourcing was built to guide companies or organisations in managing and improving crowdsourcing platforms and help job providers improve the quality of jobs provided to crowdworkers through better rewards in order to attract more participants to use crowdsourcing platforms. Deci and Ryan (2008) developed the Self Determination Theory (SDT), which specifies two motivations i.e. intrinsic and extrinsic motivation that guide individuals in accepting assignments and completing them. Individuals who possess intrinsic motivation perform tasks that give them satisfaction in terms of fun and service towards the community. Kaufmann, Schulze and Veit (2011) proposed a motivation model that consists of motivation factors. The proposed motivation model was tested on the crowdworkers using the platform, Mechanical Turk. Figure 1 shows the combined model proposed by Kaufmann et al. (2011):

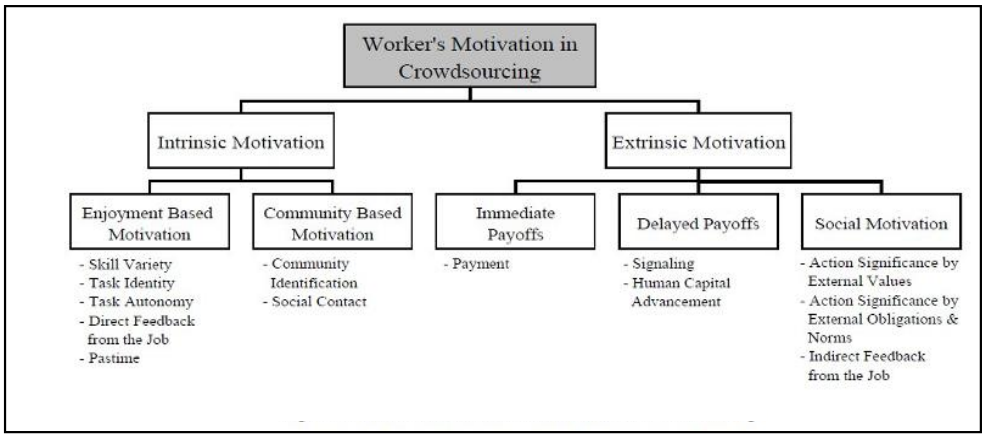

Figure 1. Combined model for worker's motivation in crowdsourcing

The motivation model categorises motivation into intrinsic and extrinsic motivation. It breaks down intrinsic motivation to enjoyment-based motivation and community-based motivation, while extrinsic motivation is classified into immediate payoff, delayed payoff and social motivation.

Intrinsic Motivation

Intrinsic motivation can be defined as motivation that originates from the individual. This motivation drives the individual to be involved in a particular task or work; the individual is self-inspired. Kaufmann et al. (2011) stated that intrinsic motivation can be enjoyment-based or community-based. In crowdsourcing activities, some workers are attracted to perform the tasks provided by job providers simply for the fun of it (Hippel & Krogh, 2003), while others seek to serve the community (Leimeister, 2010).

One reason workers participate in crowdsourcing is task variety (Kaufmann et al., 2011). Workers can make use of the crowdsourcing platform to try different skills in different tasks

offered by the job provider. The motivation of the workers might be higher if they get to participate in different types of task that can motivate them to use different skills. They may also desire task autonomy, being motivated to join the crowdsourcing platform to express their creativity (Hackman & Oldham, 1976). Task autonomy in crowdsourcing is seen in the freedom enjoyed by crowdworkers to express their creativity. Participants are stimulated (Lakhani & Wolf, 2005) to be more creative if the task requires them to go beyond their skills. Another reason for interest in participating in crowdsourcing is to meet new people (Brabham, 2010). Crowdsourcing provides the opportunity to make new friends (Hosseini, Phalp, Taylor, & Ali, 2014) who share the same interests.

Extrinsic Motivation. Extrinsic motivation drives human behaviour (Lakhani & Wolf, 2005) in participating in crowdsourcing through the promise of a payment, incentive or reward. Extrinsic motivation can be defined as the motivation to achieve a separable outcome (Ryan & Deci, 2002). This motivation originates mostly from factors affecting the individual that are beyond his own control or activation. Crowdworkers may be driven to perform tasks because of someone else or because they seek future returns, rather than to satisfy their own inner needs.

Extrinsic motivation (Kaufmann et al., 2011) may be categoried as immediate payoff, delayed payoff and social motivation. Immediate payoff is the reason that many take part in crowdsourcing. They aim to receive the monetary reward or incentive offered by the job provider. Crowdworkers seek to increase their monthly income, and it could be their primary or secondary income (Lakhani & Wolf, 2005). Workers usually receive an immediate payment after performing the task (Kaufmann et al., 2011). Karger, Oh and Shah (2014) stated that delaying payoff may reduce participant motivation to participate in new tasks. Hosseini et al. (2014) categorised the giving of an incentive for performing crowdsourcing tasks under extrinsic motivation.

Workers who are not focussed on payment do not mind responding to delayed payoffs. Payment for work may be late, but they are focussed only on future opportunities. Delayed payoff can be divided into two categories, signalling and human capital advancement (Kaufmann et al., 2011). Signalling refers to workers who joined the crowdsourcing platform in order to demonstrate their skills and performance to catch the notice of a job provider who might be interested to offer them a job (Weiss, 1995).

Hosseini et al. (2014) stated that social incentives are included in extrinsic motivation. Workers might be joining crowdsourcing platforms because they want to be recognised by their peers (Mao, Yang, Li, & Harman, 2013). Participants may also be seeking public recognition (Estellés-Arolas & González-Ladrón-de-Guevara, 2012; Bozzon, Brambilla, Ceri, & Mauri, 2013; Kazai, 2011) in wanting to be known through the network of workers and job providers on crowdsourcing platforms. This type of recognition will indirectly help the crowd receive new tasks from job providers.

Technology Efficacy. Self-efficacy is defined as "how well one can execute courses of action required to deal with prospective situations" (Bandura, 1986) . Betz and Luzzo (1996) stated

that self-efficacy is an important element in modern psychology and it is presented in Social Cognitive Theory, which states that people can be more motivated and participated longer in performing tasks if they possess self-efficacy. Technology efficacy is rooted from the self efficacy construct. It generally referes to one's ability to achieve or complete a task using technology (Compeau & Higgins, 1995). In this study, we examine technology efficacy effect in influencing the intrinsic and extrinsic motivations towards using crowdsourcing applications.

Research Approach

The qualitative method was chosen to conduct the preliminary data collection as crowdsourcing is considered a new phenomenon in Malaysia, thus this was deemed a good method for collecting first-hand information of the phenomenon. The government initiative of introducing crowdsourcing in Malaysia was intended to improve the average income of B40 groups (PM Najib Announces More Digital Malaysia Initiatives, 2014). This method was also chosen as it was believed that it could facilitate understanding of the motivation factors for participation in crowdsourcing.

Data Collection

In this phase, data were collected using the semi-structured interview method. The interview sessions were held with crowdsourcing platform users from three centres in northern, southern and eastern Peninsular Malaysia who were between the ages of 18 and 45 in order to identify the factors that motivated them to participate in crowdsourcing. The three centres in Shah Alam, Kedah and Terengganu were identified by MDeC as crowdsourcing platforms that provided activities and training for crowds in January 2016. The reason for using the semi-structured interview as the preliminary method was because the results from the interview would give deeper understanding of the motivation factors and this would help in developing an interlinked motivation model. The questions in the interview were constructed based on the motivation factors proposed in the Kaufmann model (Kaufmann et al., 2011).

Data Analysis

The interview data retrieved from 30 interviewees were translated and transcribed. The questions and answers were in the Malay language. Open coding was used to derive themes for the motivation factors identified from the interview data. The themes were then classified into factors that were then used to construct an interlinked motivation model.

Model Validation

Five expert reviewers were identified from the existing crowdsourcing platforms in Malaysia to validate the proposed interlinked motivation model, but only three managed to complete the model validation. These experts were chosen based on their experience in using and managing the crowdsourcing platforms as well as education level.

Findings

There were 30 participants interviewed where 53% were female and the rest were male. 31 % is the highest percentage of paricipants in the age group of 31-35 years old. For education, participants with a diploma held the highest percentage compared with those who had SPM qualification (70%), while 55% of the participants earned between RM1100 and RM1500. All the interview participants owned a smartphone and 60% stated that they were skilled Internet users, with 50% of the respondents using the Internet more than 5 hours per day.

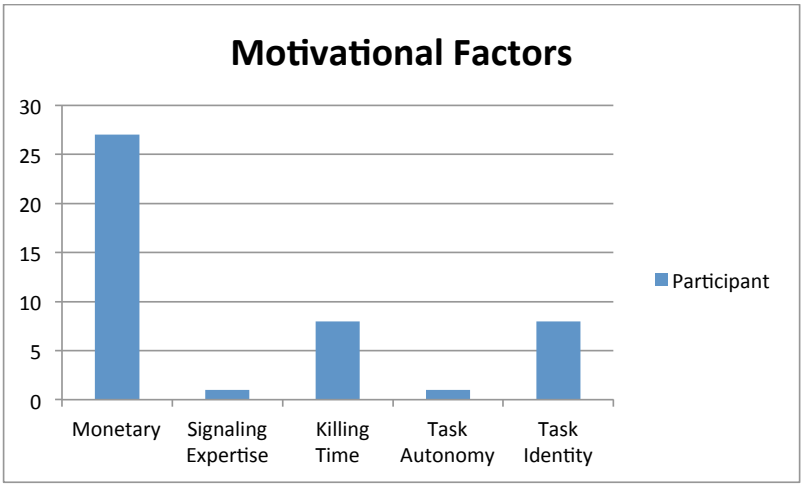

Figure 2. Motivation factors

Extrinsic Motivation

Based on the data collected during the interview sessions as shown in Figure 2, almost all the participants mentioned that money was the main factor that motivated them to participate in crowdsourcing, making monetary concerns a strong factor under extrinsic motivation for participating in crowdsourcing. Below are some of the responses from the participants.

> Main motivation is of course income. Second…. I think it is still income.
>
> (Participant 3)

> I join crowdsourcing platform because I want to generate income and increase it (income).
>
> (Participant 22)

Some of the workers participating in crowdsourcing activities aimed to earn additional income. There were also crowdworkers who performed crowdsourcing tasks as a part-time job as they were labelled low-income citizens who were among the B40 group. By participating in crowdsourcing activities, they were able to earn an additional income. Most crowdworkers are paid based on the difficulty level of the task as motivation to keep participating in the activities.

Monetary motivation includes reward motivation, as coupons rather than cash was sometimes offered as payment for tasks completed. The participants stated that they sometimes received coupons that could be used to buy groceries.

> At least I get vouchers. Even though they also offer money as payment, I choose vouchers. Sometimes I can get a RM20-voucher that can be redeemed in Giant, Jusco and other outlets. I target a number of vouchers I can get in a month and use them for groceries and home appliances.
>
> (Participant 3)

Other than the monetary factor, signalling expertise was also a factor, as pointed out by one participant. The interviewee stated that the reason for participating in the crowdsourcing platform was to be identified and recognised as a worker in the crowdsourcing market. However, this factor was not chosen as a motivation factor based on the experts' recommendation as only one participant had mentioned it.

> I have long-term expectations for participating in crowdsourcing. I want to be known as a crowdsource worker and I want to build my own profile in the crowdsourcing market.
>
> (Participant 17)

Intrinsic Motivation

Other than extrinsic factors, intrinsic factors were also mentioned by the participants as motivation for participating in crowdsourcing. Under the category enjoyment-based motivation factors, three factors were mentioned by the participants: killing time, task autonomy and task identity. As shown in Table 1, eight respondents stated that by participating in crowdsourcing, they could utilise their free time very well.

> I participate in crowdsourcing to fill free time and also to generate income.
>
> (Participant 1)

> Definitely to kill time, when we do not have any work to do, we can perform these tasks anywhere.
>
> (Participant 17)

As stated by Hackman and Oldham (1976), crowdworkers are allowed to express their creative ideas; this freedom is known as task autonomy. In the interviews, task autonomy was mentioned by one respondent, who noted that crowdsourcers were given authority and freedom in performing their tasks. They were free to contribute their ideas regarding the.

> The motivation is actually independent. No people will scold us if we make a mistake when performing the task.
>
> (Participant 17)

Another motivation related to intrinsic factors was task identity. Based on task identity in this study, eight participants stated that the idea of performing an activity online motivated them to participate in crowdsourcing. Several participants were attracted to the way tasks or work was presented and they enjoyed completing the tasks.

> I really love activities related to the computer, and that motivates me to participate in crowdsourcing.
>
> (Participant 16)

> I joined crowdsourcing because I love activities that are conducted online. It motivated me to join the crowdsourcing platform.
>
> (Participant 17)

Technology Efficacy

Technology efficacy was mentioned by the respondents as an interlink for moderating intrinsic and extrinsic motivation in encouraging workers to participate in crowdsourcing activities. Technology efficacy referred to computer training.

> Computer training assists users in performing the given task and at the same time, helps to improve users' skill in using computers and the platform.
>
> (Participant 2)

This underscores the importance of technology efficacy in controlling user motivation for participating in crowdsourcing. Users need to have at least a basic knowledge of technology to enable them to perform crowdsourcing activities.

Interlinked Motivation Model

Based on the data collected from the interview, an Interlinked Motivation Model for intention to use a crowdsourcing platform among the B40 group was proposed (see Figure 3).

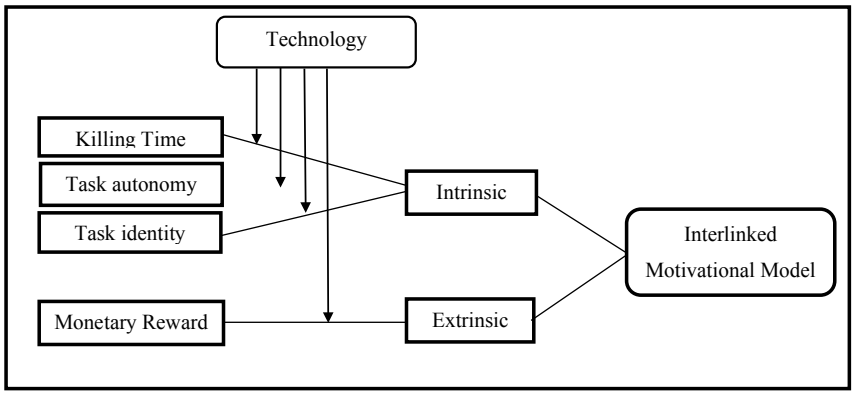

Figure 3. Interlinked motivation model

CONCLUSION

In general, monetary reward was stated as an important motivation that drove the participants to crowdsourcing. However, intrinsic motivation factors such as killing time, task autonomy and task identity were also important to current crowdsourcing platform users. This study showed that crowds not only participated in crowdsourcing activities just to generate income but also because they enjoyed performing various kinds of tasks.

The model proposed in this study has not yet been implemented in crowdsourcing. The data extracted from the interviews were for identifying current motivation factors in crowdsourcing. It is recommended that future studies test the proposed interlinked motivation model in order to help efforts to enhance participation in crowdsourcing among low-income citizens.

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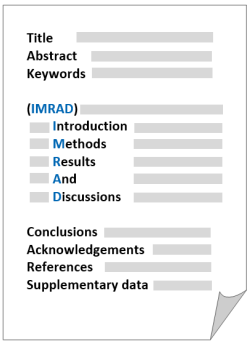

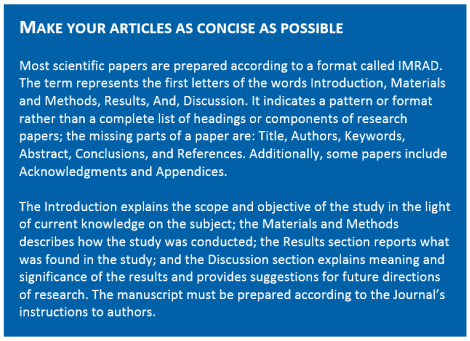

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