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Reward System for Completing FAQs

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Abstract. The creation of Answer Communities around a FAQs Site is proposed to speed up the process of answering questions. Our approach combines long-term and short-term rewards. Long-term rewards are found to boost participation, motivating users to complete FAQs with proper answers faster.

Keywords. Frequently Asked Questions (FAQs) Sites, Answer Communities.

1. Introduction

One of the most straightforward ways to learn the answer to a question is by asking someone who has intimate knowledge in the field of question. Internet-based exchanges of knowledge and information in the form of questions and answers have emerged and grown along with the development of the Internet [1]. Companies such as Yahoo! have indexed the answers making this resource even more powerful. They were initially called Markets of Answers. We name them *Q&A Communities*, or social Q&A, as places where community of people response to specific questions. Based on logs from popular search engines, approximately 15% of all queries posted are fully-formulated questions [2]; however, the documents resulting from keyword searches might not even contain the answer, or they might contain false answers.

Radev [3] concludes that when posting complete questions to search engines, correct answers are only returned 3/4 of the time within the first 40 returned results. This shows that there is a great need to provide more *precise answers* instead of merely a list of links to documents that potentially hold the answer. However, the quality of the results for plain text questions is likely to degrade even further if question-answer (QA) systems do not become an integral part of regular search engine technology.

What might go well with complete questions is the search through Frequently Asked Questions (FAQs). Listing FAQs is one popular way of sharing inquiry-based information on the Internet. This information distribution mechanism works for individuals who are sufficiently interested in a matter but not for users with a passing interest, who might have a specific question, but do not want to read dozens of messages about the question topic [4]. However, a FAQ list has several drawbacks

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when compared to an interactive QA system of an Answer Community. If the list is too small, the questions will most likely not adequately cover the topic. A large list, however, can be intimidating to read through and yet still is not guaranteed to provide the correct answer. Another problem is that there is no straightforward way for an administrator to find out what types of questions clients or citizens have. This can be solved by providing some sort of feedback, such as email, but usually a user will want the question answered right away and will thus search elsewhere for an answer before submitting any feedback. If feedback were provided, an administrator could theoretically refine the FAQ list. Furthermore, one of the greatest drawbacks of static FAQs is that the user is not given the option to ask free-form questions, but rather is forced to re-phrase his or her question so that it matches one of the FAQs. Thus, having all the possible FAQs is critical. To solve this problem, creating answer communities around the FAQs and giving them methods for contributing their answers might fill the lists faster, as pointed in [5].

2. State of the Art of QA Communities

Market-based institutions offer mechanisms to evaluate knowledge and to design incentives to motivate and support valuable knowledge transfer [6].

InfoRocket developed a buyer-driven model: a buyer posts a question and price (with legal currency) and providers will answer to earn it. The buyer chooses one provider, pays him, and assesses the quality of the answer. An answershop *incentivized* the quality of answers, because good answers were more likely to be accessed repeatedly, thus provided an annuity for their providers. It offered various modes of interacting with experts; an automated system connected buyers to providers, or, if buyers preferred, they could listen to previously-recorded advice instead. Advisors could also be contacted by e-mail for follow up questions or other inquiries [1].

In *Yahoo! Answers,* the whole community makes questions and answers. It is a model of rewards for activity in points (not legal currency). Asking a question is equivalent to expending 5 points. This simple rule is very powerful; it motivates a critical number of users to answer questions to earn points and go on asking. On the other hand, heavy users tend to answer many questions without the apparent need for reward. They seem to enjoy the status they reach by accumulating many points.

Google Answers (online until Dec. 2006) community consisted of "Researchers" who provided answers to questions. Each question displayed an associated price (that varied between $2 and $200 per answer) as well as post-answer monetary tips and ratings. Each question could be discussed and commented in a free way by all. However, all published answers appeared only after the payment of a fee.

Askville is a user-driven research site founded by Amazon.com that opened to the public on December 8, 2006. Users gain or lose "experience points" in particular topics as they answer questions on those topics; their points depend on the quality of their answer [7]. Users also receive "quest gold coins" by asking and answering questions and by voting on the value of other users' answers. The user can then use these coins as rewards either to obtain more coins or to exert voting influence regarding answers.

3. A New Formulation of Rewarding

Our approach departs from [5] and explores the benefits of long-term rewards, so that users will *invest* in Q&A community currency for posting answers aiming at higher benefits in the long term. Creating such currencies makes important shifts in the behavior of the communities as explored in [8] [9]. We propose that questioners reward answerers with their own points as Yahoo Answers does. Rewards are made with complementary community currencies (points) rather than legal tender. This pressures users to answer questions to earn points necessary to ask questions. Our first contribution is that our approach does *not* require that every answer be public. Answers must be posted after negotiation among answerers, and in some cases not post at all may take place. Thus, every answer has an owner, who is responsible for maintaining it.

The conversion of points into a fully complementary community currency should encourage higher user activity. However, such currency systems must be properly designed to avoid the drawbacks of such currencies [10], namely, inflation or lack of use. Table 1 shows a comparison of discussed approaches. Remark that our approach is different from the State of the Art as we use auctions to decide what QA are published. The answerers bid for the publication of QA that they expect potentials rewards in the future. Also, the answerers will be responsible for the maintenance of those QA, that is to say, they might improve their QA for further future rewards.

Table 1. Comparison of approaches to Answer Communities

Web 2.0: Answers	Pressure to Questioner	Rewards by Activity	Questioners Reward	Ownership of Answers	Legal Currency of Rewards	Maintenance of Answers	Community Approach	Sucess
Yahoo Aswers!	Yes	Yes	No	No	No	No	Yes	Leader 2009
Askville	No	Yes	No	No	No	No	Yes	Beta 2009
Google Answers	No	Yes	Yes	No	Yes	No	No	Failure 2006
InfoRocket	No	Yes	Yes	Yes	Yes	No	No	LiveAdvice 2001
Our Approach	Yes	Yes	Yes	Yes	No	Yes	Yes	Beta 2009

4. Combining FAQ and Personal Knowledge Exchanges

Let an *Answer Community* be the set of users or agents that make questions Q, and those who answer A, comment and rate (all of which are Q and A). We are going to assume that the best person to answer a question is the one who most wants to do so [11] and people able to best evaluate the performance of answerers are their friends and peers, who enthusiastically improve the final answer helping each other to create something from which they all will benefit in the short- or long-term. The hypotheses of how to boost participation are displayed in Table 2.

We suggest temporary ownership (H3.3) to encourage new owners to distribute maintenance tasks in a more democratic, or even "crowdsourced" way [11], that empowers the community to organize itself for the maintenance of the answers. We tested Hypothesis 1 and 2 using some theoretical experiments aimed at obtaining a complete FAQ list. We defined some measures to observe the impact of rewards. The experiments were run inside a fixed temporal concession window.

4.1. Frequently Asked Questions: the Measures

FAQs have speed as their main advantage, though they usually present few answers. In order to have all questions answered quickly, the FAQ list must be complete which usually is accomplished with help from users, so actual users and experts are necessary. While experts were previously able to excel in the acquisition and interpretation of exclusive information often by studying in fine colleges, and acquiring privileged access to information, today this distinction is disappearing due to the Internet and universal access to education [11]. Moreover, it is impractical and virtually impossible for experts to synthesize *all* QAs in a given area, they cannot imagine all possible questions and answers, including the many ways in which questions can be formulated due to jargon, language imprecision, omissions, and default knowledge.

Table 2. Hypothesis of How to Boost participation

Hypothesis 1 Questioners pay for automatic answers to questions by means of QA searchers at one rate for but they negotiate a price for customized answers from users. Tips can be paid. This hypothesis is called the "short-term incentive."	***Can be broken down into options compatible with payments:*** H1.1. User Q directly pays user A. H1.2. User Q pays the winner of an auction his/her bid.
Hypothesis 2 Not all answers are posted and accessible through QA searchers; users compete for the publication of their answers [11]. Publication means that a user can post his answer and earn payments for automatic answers through QA searches. This is the "long-term incentive."	***Can be broken down into options compatible with publication:*** H2.1. User A, chosen by Q, is the one who publishes and is paid a fix amount. H2.2. User A, chosen by the public through a vote, has the right to publish, after being paid a fix amount for this right. H2.3. User A, the winner of an auction, is paid according to the terms of an auction (as a type of negotiation) [13].
Hypothesis 3 Maintenance must be performed by the owner of answer A. We define the *owner* of an answer (or QA) as the one who publishes that answer and earns payment from every search for that answer with the QA search engine. The owner can edit his/her QA, decide whether to incorporate comments from other users, and let other users directly edit his/her QA.	***Maintenance can be work with compatible options:*** H3.1. The owner maintain his/her QA to obtain better payback for his/her investment from QA search engines. H3.2. The owner sells his QA so that other users can complete maintenance. Then H3.1 applies for the new owner. H3.3. Ownership is temporary under a concession time, so that the QA is regularly put up for auction to rotate who maintains it. Under concession time, H3.1 and H3.2 apply.
Corollary. A Complementary Answer Community Currency (CACC) must be designed for a specific Answer Community so that its participants can be rewarded for answering the questions with this currency. The currency should either provide status to holders or be redeemable for products or services that they value. However, the CACC should not be convertible into legal tender. To the best of our knowledge, the first CACC backed by knowledge is the wit [12]; in this paper, we propose to use points or bits as a CACC.	

In addition, the world of knowledge is continuously changing, so that what is true one day might not be true the following day. Therefore, gathering knowledge in the form of QAs is a growth process under continuous revisions (maintenance), which can be enhanced through cooperation between experts and users. Users (as well as experts) can be encouraged to engage in the QA synthesis process by empowering them with tools for answering questions. For two reasons, the users are good answering questions. First, users tend to be best at understanding the problems of other users. They are insiders, and they understand the ways questions are posed. Second, they can share their personal experiences as users in their answers.

The measure of success for any QA model is the extent to which any question can be answered by means of an automatic search engine. When 100% success is reached,

the FAQ list is said to be **complete**, that is, the FAQ list has *all* answers to *all* questions. This is theoretical but useful to design experiments appropriate to measure the impact of incentives, as we assume that the more motivated users, the more complete FAQ.

4.2. Measures

The simplest measure is the number of questions with an answer in the FAQ list found through a QA search engine. Let us define the *primary index* as I_α, with f the number of questions and q the number of answers provided by the FAQ list: $I_\alpha = \frac{q}{f}$

We consider I_α satisfactory if $I_\alpha = 1$ or $I_\alpha \geq 1 - \varepsilon$ for any little $\varepsilon \in (0, 1]$. The *primary index* is defined as $(I_\alpha \mid T) \leq 1 - \varepsilon$, with T being a temporal window for questions.

Let us define the *secondary index* as I_β in order to measure long-term motivation. We directly measure the number of publications n in the FAQ list or the number of QA transactions m among users ($n < m$), or we indirectly measure the number of points k earned by answerers. Thus, there are several ways to calculate the secondary index I_β within the temporal window T:

$$I_{\beta_1} = \frac{n}{T} \quad ; \quad I_{\beta_2} = \frac{m}{T} \quad ; \quad I_{\beta_3} = \frac{k}{T}$$

Since I_α and I_β are measurable empirically but not in simulation, let us define the *tertiary measure* I_τ $I_\tau = \tau$

where τ is the time constant from the linear model of the dynamics of I_α. It is modeled as follows: $I_\alpha(t) = 1 - e^{-\tau/t}$

The third index is related to the completeness of the FAQ list and is calculated as follows $I_\tau \to 0 \implies I_\alpha \to 1$

Thus, the lower I_τ, the more quickly the FAQ list will be *complete*, or in other words, the maximal number of QAs are in the list, and therefore *any* question will find its answer in the FAQ list. As the FAQ list becomes *complete*, $I_\alpha \geq 1 - \varepsilon$ becomes true for smaller and smaller ε, as well as $I_\tau \leq \varepsilon$. Our goal in these theoretical experiments is that both indexes in the long-term (i.e., infinite time) tend to the following asymptotic values:

$$I_\alpha \to 1 \; ; \qquad I_\tau \to 0$$

When these two conditions are fulfilled, the secondary index I_β will have had grown in one of its sub-indexes, which means that long-term motivation has grown. As a matter of fact, the more motivation there is, the shorter will be the time until the FAQ list is complete. Heuristically, we argue that the *shorter the time between the FAQ list reaches the maximal amount of questions and answers, the more likely it will be complete at any given time one user could put a question forward*.

Thus, we conclude that if any improvement I_α is observed then the FAQ list is more likely to be complete. And any improvement in I_τ means there is further incentive and more motivation among users to answer questions, thereby accelerating the completion of the FAQ list. Let us turn to the experiments.

5. Experiments

5.1. Theoretical Model

We assume a universe of infinite number of users that pose questions and answers consisting of a finite set of $\Phi = \{a, b, c, ..., z\} = \{\varphi_i\}$, $i = 1, ..., 26$, where every letter φ_i is a QA (this model of course easily generalizes to an arbitrary number of letters $i = 1,\ldots k$).. Let us suppose that the questions numbered 1, 2, ..., 26 are posted with the following distribution $p(\varphi_i) = \frac{1-e^{-1/i}}{\sum_{j=1}^{26}(1-e^{-1/j})}$ which corresponds to a "long tail" distribution, so that the probability that the first five QAs, *p({a, b, c, d, e})*, are posted is higher than the probability of the 21 remaining QAs.

The probability of a user being aware of a question and at the same time having any knowledge useful for answering that question is p_a, and it is called the probability of *awareness*.

There are two types of probabilities that a user answers with high motivation when he/she is aware of a question, depending on whether the perceived benefit is short-term or long-term. The short-term probability is denoted as p_c and it models the probability of acting after receiving an immediate reward for an answer. The short-term reward is currently the only rewarding mechanism in effect in actual Answer Communities, as discussed in earlier sections. The long-term probability, denoted as p_l, corresponds to the probability a user is motivated by a future reward, after an investment which depends on the remaining chances he has for winning a bid to publish his answer.

To perform the experiment, we make the following estimations:

1. A moderately active user is aware of one third[2] (1/3) of the posted questions and feels sure enough to answer half of them[3] (1/2*1/3=1/6). As a result, an average user can answer 1 out of 6 posted questions, thus, p_a = 16.7%.
2. p_c = 80%. Most members are highly motivated in terms of short-term rewards[4].
3. $p_l(\varphi_i) = \max(p(\varphi_i), p(\Phi - \{\varphi_i\}|\Theta))$, being $p(\varphi_i)$ the probability a question is posed whose answer is known in advance by users. This is a theoretical but effective assumption. $\Theta = \{\varphi_{j_1} .. \varphi_{j_n}\}$ is based on the probability that there are posted questions, which some users have enough knowledge to answer.

5.2. A Functional Model

The intensive contributors consist of a community of 15 users, each with a partial knowledge regarding the full set of questions-answers Φ defined by Table 5. The first five users, A1-A5, are more willing to contribute than the others, and overall, these 15 users are motivated to answer 80% of questions on average, provided that they are aware of or available for questions. In this functional model, the full procedure is designed as follows. A continuous stream of questions comes to the FAQ queue; when there is no answer to a question, the 15 users are 20% capable and available to answer it. Of those who answer the question, some will compete in an auction to publish it in

[2] We consider that there are 3 categories, and each user answers only in one category.

[3] We consider it a 50% uniform distribution as we do not have any apriori knowledge of its distribution

[4] We consider 66%-99% that represent *the most* of contributors

the FAQ list. The winning user will receive rewards from every future questioner who finds his/her related answer in the FAQ satisfactory.

Table 5. Users and their Knowledge in the Experiment

Users	Knowledge
A1	*{'a', 'k', 'm', 'o', 'w', 'z'}*
A2	*{'a', 'l', 'o', 'p', 'q', 's', 't', 'w', 'z'}*
A3	*{'b', 'c', 'd'}*
A4	*{'e', 'g', 'j', 'k', 'r', 'u', 'b', 'c', 'v', 'x', 'y', 'z'}*
A5	*{'f', 'h', 'n', 'v', 'x', 'z'}*
A6	*{'c', 'f', 'g', 'h', 'i, 'j', 'm', 'n', 'o', 'p', 'q'}*
A7	*{'d', 'e', 'f', 'j', 'k', 'l', 'm', 'r', 'y', 'z'}*
A8	*{'a', 'b', 'c', 'd', 'f', 'g', 'h', 't'}*
A9	*{'j', 'k', 'l', 'm', 'n', 'o', 'p', 'q', 'r'}*
A10	*{'a', 'b', 'c', 'd', 'e', 't', 'u', 'v', 'w', 'x', 'y', 'z'}*
A11	*{'c', 'm'}*
A12	*{'r'}*
A13	*{'e', 'd', 'i', 't', 'h'}*
A14	*{'l', 'm', 'q', 'x'}*
A15	*{'d', 'f', 'i', 'l', 'o', 'p', 'u'}*

This functional model takes into account several factors. It accounts for users motivated by the short-term, immediate reward of answering questions as well as users motivated by long-term, post-publication rewards. Bids are implemented rationally. The higher is the probability of recurrent appearance of a question and the fewer are the opportunities to win the bid, the higher will be the percentage of total points that a user is willing to assign to a bid. The experiments were conducted in a series of three runs per every initial wallet. The initial wallet is the total number of points assigned to a user upon sign-up at the beginning of the simulation. The initial wallets are 0, 50 and 100 points. Table 6 shows the results in terms of the time (measured in cycles) required to complete the FAQ list (that is, reach 26 QAs).

Table 6. Initial Wallets and Time to Complete

Initial Wallet	Time to Complete the FAQ
0	31
50	31
100	32

Table 6 reveals that, as predicted by the theoretical model, the FAQ lists are filled after a number of cycles. However, the higher initial wallet is, the longer the FAQ list will take to be completed. The diversity introduced into a community of 15 users has appeared to undermine the capacity of our model to quickly complete the FAQ. This diversity introduces interesting behavior regarding the type of motivation that drives users. Let us analyze Table 7, which shows the number of points at the end of the runs.

Table 7. Accumulated Points for Given Initial Wallets

Users	10	4	7	2	9	6	5	8	1	13	14	15	11	3	12
0	2108	1475	1218	1106	953	951	945	853	658	511	382	242	199	186	159
Users	10	4	7	6	2	5	15	9	12	1	8	14	13	3	11
50	2275	2031	1864	1616	1563	1477	1436	1432	1425	1407	1404	1392	1234	724	564
Users	10	4	12	15	6	7	14	9	1	2	13	8	5	3	11
100	2706	2696	2620	2610	2443	2378	2190	2051	2034	2011	1985	1783	1735	1072	971

From Table 7 one can easily see that users 12, 15 and 14 tend to perform better with bigger wallets. These users are the worst performers in terms of published answers.

That is, they do nearly no publishing, meaning they are not motivated by long-term rewards. In particular, user 12 had no published answers, as depicted in Table 8.

Therefore, high initial wallets received as sign-up points are not conducive to earning long-term rewards, since users with low responses to long-term rewards perform much better, which increases the global time necessary to complete the FAQ list. Our conclusion is that diversity is good, and contrary to current practices in Answer Communities, it is better not to give sign-up points to new users but rather to encourage them to earn points by answering, publishing, and do activities.

Table 8. Total Number of Published Answers as a function of Initial Wallets

Users	10	4	2	9	7	6	8	5	1	13	3	11	14	15	12
0	197	122	94	83	56	54	53	47	26	23	9	8	5	3	0
Users	10	4	9	2	5	6	7	1	8	13	3	11	14	15	12
50	135	88	86	77	68	64	64	55	39	34	31	30	7	2	0
Users	10	9	2	4	5	7	1	8	6	3	13	11	14	15	12
100	110	85	81	81	72	59	57	57	56	36	32	29	16	9	0

5.3. Results

The simulation consists of several runs, with every run consisting of 500 simulated questions. Let us observe the behavior of three models: the optimal model, consisting of all questions having an answer that is also published in the FAQ; the classical short-term reward model, consisting of all answers that are posed and sometimes published with probability of awareness p_a and short-term reward probability p_c; and our long-term reward model, proposed in this paper. This last model is based on long-term reward, so that in addition to the probability of awareness p_a and short-term reward probability p_c, users bid for publication in the FAQ list if they expect a long-term reward and can benefit from their investment, as modeled by p_l.

The following Figure 1 plots behavior during the optimal model after one run. The following indices are represented as I_α = *#hit/#q* (the lower curve, on a scale of 0 to 10, is the number of times an answer is found in the FAQ divided by the number of questions) and the number of QAs in the FAQ (the higher curve, from 0 to 26 letters):

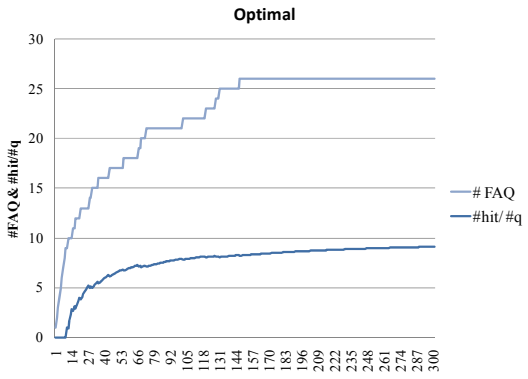

Figure 1. The Optimal Behavior

The FAQ list tends to become more complete as long as there are more questions. In addition, as FAQ list becomes more complete, I_α tends to 10/10, that is, 100% of questions are answered. The time constant for I_α is I_τ = 48 questions.

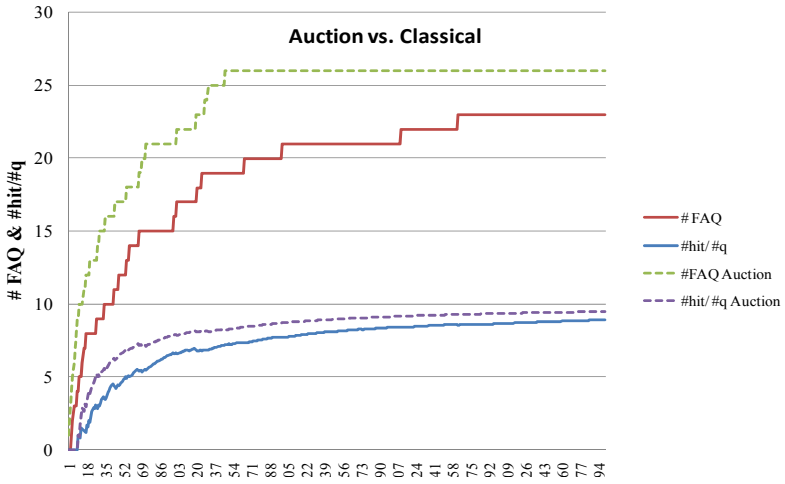

Figure 2. Long-term (dashed line) Compared to Short-term Rewards

Figure 2 plots the classical model (short-term rewards, represented with solid line) underperforming our model (long-term rewards, represented with a dashed line). From the plot, one can see how the long-term reward approach completes the FAQ list much sooner than the short-term reward approach, that is, $I_\tau = 48$ questions versus $I_\tau = 89$ questions, respectively. As a consequence, the long-term reward approach has, on average, a higher impact than the classical model. Thus, the long-term reward approach reaches an optimal value within 48/89 = 53.9% of the time required by the classical, short-term reward model. Table 2 summarizes the results of the three models after 25 stochastic independent runs.

Table 3. Effects of Optimal, Long-Term and Short-Term Rewards

	Optimal	Long-term	Short-term
$average(I_\tau)$	53.44	55.72	91.52
$deviation(I_\tau)$	8.21	8.74	16.75
time constant of complete FAQ	41.88	42.20	87.64
and it is desviation	12.90	12.91	34.24

Table 3 shows that the long-term reward model reaches a maximum performance of I_α at 60.9% of the time required by the classical, short-term reward model. It is only 3.7% slower than the optimal model. The improvement in the tertiary (and primary) index shows that the FAQ list is completed by the long-term reward model within 48.2% of the time required by the classical, short-term reward model; the time for completion in this model is quite close to the optimal (only 0.8% slower).

When compared with the only short-term rewards, the combined short and long-term rewards fill the FAQ list in a shorter time, with higher probability of having the FAQ completed at any time. As a further evidence of the improvement, the performance of the primary index I_α = *#hit/#q,* measured as the number of questions that receive an answer from the FAQ list, is maximized.

6. Future Work

Our conclusion is that the Q&A Communities should function better (faster answers by filling faster the FAQ lists) with both long-term and short-term rewards by means of Q&A community currencies. Contrary to current practices in Q&A Communities, it is better not to give sign-up points to new users but rather to encourage them to earn points by answering, publishing, and doing activities. These results are obtained in simulation and will be tested in real experiments in the framework of RDiSAC project "*Recerca en incentivació de la participació 2.0...*" with public administrations.

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