IRMA BORST

Understanding Crowdsourcing

Effects of Motivation and Rewards on Participation and Performance in Voluntary Online Activities

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in voluntary online activities

Over uitbesteden aan de massa

Effecten van motivatie en beloningen op deelname en prestaties
in vrijwillige online activiteiten

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Foreword

It was not obvious that I would start a PhD project; it was not my long-cherished wish. When I started my working life as a nurse, I did not dream to become a doctor somewhere in the distant future. But after my move from the health sector to management consultancy and involvement in a number of research projects, I slowly grew into the idea of engaging in scientific research. Through the projects Ecolead and B@home, I discovered that research is more interesting and challenging than I suspected. Together with Jan van den Ende, I submitted a research proposal to NWO (Dutch Scientific Association). We were very happy that financing for our project was granted.

Jan has not only played a crucial role in the initiation of my PhD project, but also in the entire execution. As my promotor, Jan was very much involved in my day-to-day research activities. I could always knock on his door for advice, which I certainly did. In particular, the mathematical knowledge that Jan shared in the interpretation of the Negative Binomial Regression was invaluable to me. When looking back, I see clearly that Jan's critical and additional, new questions – which I was not happy with at the time they were raised – led to the significantly improved results of my research. Jan, thank you very much for being a very supportive and stimulating promoter!

Two other persons, Eric van Heck and my Logica colleague Geleyn Meijer were closely involved in my thesis project. Thank you, Eric and Geleyn for providing regular feedback on the intermediate results and providing advice on how to move on to the next activities, all with the goal of spurring on my research project. A further word of thanks goes to the other professors that are in my committee: Gerrit van Bruggen, Petra de Weerd-Nederhof, Nico van Yperen, Chris Tucci and Harry Barkema; thank you for taking up the task of committee member.

Although not a member of my committee, I really would like to thank Michael Jensen who acted as a friendly reviewer before Jan and I submitted our article to a journal. His

suggestions for new analysis appeared to be extremely valuable and I hope that we will succeed in publishing our article in a top journal.

Besides the support of academic colleagues, I also received a lot of support from non-academic people. First of all, I would like to thank the crowd of respondents. Over 1900 respondents revealed their motivations for their online behavior. I calculated that this crowd jointly spent 282 hours on filling in the websurveys, therewith contributing more than 7 weeks of work to my research. I would also like to thank Wilbert de Vries (Deputy General Editor, Tweakers.net), Jesse Burkunk (Product Manager, NUfoto.nl) and Femke Rotteveel (Coordinator Green Challenge, Dutch Postcode Lottery) who provided me with essential information on the participation and performance of respondents. They facilitated the data gathering from multiple sources which is a major strength in my research design. I would also like to thank the expert panelists that plaid a crucial role in the NUfoto.nl and the Green Challenge studies. Renata Bauer, Bart de Rijk and Dirk Schiemanck: thank you for spending your free time on the assessment of more than 750 newsphotos. Marjolijn Bloemmen, Jeffrey Prins and Femke Rotteveel: thank you for assessing the business plans, each 5 to 10 pages long, of the Green Challenge respondents. Without the work of these two expert juries, I would not have been able to reach the conclusions presented in chapters 6 and 7.

Next I am convinced that the help of Jordan Srour and Michael van Roosmalen substantially improved the quality and readability of my thesis. Jordan, thank you for the language check. And Michael, my personal graphical advisor, thank you for the nice graphics and the lay-out of this thesis. It is a pity that our experiment to use graphical tools in the interpretation of empirical data, did not work out as we expected. I was convinced that you could sell your solution to SPSS.

Financial compensation is not only an important topic in my studies, but it is also enabled my PhD project. NWO financed two years of research as part of the Network of Networks Program. Novay and RSM provided additional funding so that I could extend my research with another nine months. And finally Logica allowed me to engage in this research project.

I would like to mention that Logica's support fit extremely well with Logica's penultimate slogan 'releasing your potential'. I doubt whether I would have started without financial support. Therefore the contributions of NWO, Novay, RSM and Logica were crucial for my thesis.

In this thesis, I cannot leave my social networks unmentioned. I very much enjoyed being part of RSM's Department 6. I especially appreciated the lunches with my colleagues Dirk Deichmann, José Larco, Mahmut Ozdemir, Yugang Yu, Erik van Raaij, Henk de Vries, Nima Zaerpour, Amir Gharehgozli, Melek Akin, René de Koster, Daan Stam, Nishant Mishra, Costas Lioukas, Serge Rijsdijk, Koen Dittrich and Tony Hak, in which we had nice discussions on cultural differences and in particular on the Dutch habits. I noticed the hard work of my university colleagues; I was definitely not the sole person working on Saturdays on the 10th floor of the T-building. Department 6 was a very stimulating environment for me.

My networks of (ex)colleagues, friends and family showed considerable interest in the progress of my PhD project. I can now say: it's almost done. The defense is the only task left. My collegial network mailed me a variety of questions that I can use in the preparation of my defense. I believe that I have two excellent paranimfen who will support me during the defense. Thank you, Elfi and Lonneke for your willingness to take up this task. But more importantly: thank you for your friendship. The two of you show that it is not true that good friendships can only be forged at young ages; it appears to be possible after your 30th or even 40th year.

I finally come to my strongest ties. My parents, Arnold and Thea Borst, taught me the attitude that 'you can win if you want, if you want it you can win'. They now can be proud of their daughter. I am convinced that Joop and Wies Balk share these feelings for their daughter-in-law. Dear Annemijn and Sarah, both of you would like to become writers. I think that it is an excellent idea, because it gives so much satisfaction to have a self-written book. Dearest Marcel, together, we live our 'have-it-all life' with our two daughters, our jobs and our life at home. Thank you for sharing this altogether with me.

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Chapter 1. Introduction

1.1. Research challenge

Companies increasingly outsource activities to volunteers approached via an open call on the internet. In general rewards are absent or small. When rewards are present, they take the form of recognition on the website or monetary prizes for the best contributions. Well known examples of firms outsourcing business activities to internet communities are YouTube (production of user generated content) and Lego Factory (design of new products). Although the benefits of outsourcing to online volunteers are obvious, outsourcing organisations become dependent on online community members for delivering the desired number of contributions and adequate level of usefulness and novelty. Firms, however, run the risk of receiving high numbers of low quality contributions. Firms using online volunteers often wonder how the different motivations of its community members relate to their participation and performance in terms of quantity, usefulness and novelty of their contributions, and how might rewards affect these relations.

To date, the literature on open source and online communities has not investigated the effects of motivation on participation and multiple performance aspects. The effects of rewards in online communities are also not addressed. Although psychologists have done extensive research on the motivation of volunteers in the offline world, these researchers did not reach consensus on the effects of motivation and rewards. Therefore the research challenge is to study the effects of intrinsic and extrinsic motivation of online volunteers and how rewards influence this relation.

In this thesis empirical studies on the effects of motivation and rewards on participation and performance are described. We studied three online initiatives: a discussion forum on IT news Tweakers.net, user generated news photographs on NU.nl and submissions to the Green Challenge innovation contest for sustainable products and services. These three cases differ significantly in the provision of rewards. While Tweakers.net did not provide any financial rewards, NU.nl paid small prizes for exceptional contributions and finally the Green Challenge paid a substantial amount to the winner of the contest. In all cases reputation rewards were provided.

In the three studies the motivation of online community members was measured through a websurvey – almost 1,900 respondents completed this survey – while data on participation and performance measures was gathered at the firm organizing the voluntary contributions. We present the results and conclusions of these studies and lay the path for future research.

1.2. Online voluntary contributions

1.2.1. Size and nature

Every day, millions of people make all kinds of voluntary online contributions. YouTube receives hundreds of thousands of videos daily. Every minute, 24 hours of video are uploaded to YouTube [1]. Thanks to its voluntary contributions, the Dutch version of Wikipedia counted 300,000 lemmas six years after its start (May 2007)[2] and was able to extend its encyclopaedia to over 600,000 lemmas in June 2010[3].

Not only are the massive numbers of contributions impressive, but also the variety of contributions. People searching for the crashed airplane of billionaire Steve Fossets in the Nevada desert with Google Earth[4] is, for example, a complete different activity than the design of new toys with software from Lego Factory[5].

Cook (2008) provided a taxonomy for user contributions. He distinguished between active and passive user contributions. Examples of passive user contributions are the searches generated by a massive number of people, which form the basis of Google's search engine algorithm, or persons' buying behavior which determine the product recommendations at Amazon.com. In case of passive user contributions, people do not provide their contribution intentionally. They may even be unaware of the value that their behavior has for the firm aggregating these contributions. Active user contributions consist of those contributions that users provide intentionally, such as multimedia content (text, pictures, audio or video), software code and ratings. In this study we will focus on active user contributions, since rewards and motivation are only relevant in situations where people provide their contributions intentionally.

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1 http://www.youtube.com/t/fact_sheet

2 http://www.fan.tv/digitaal/toontext.asp?id=5027

3 http://wikipedia.josemanuelperez.es/nl?lang=nl

4 http://www.gearthblog.com/blog/archives/2007/09/help_find_steve_fosset_with_google.html

5 http://factory.lego.com/

A different categorization can be derived when following a firm's perspective. A firm can use online volunteers for operational and for research and development (R&D) activities. Online volunteers provide, for example, an operational contribution when serving as 'citizen journalists' for an online news site (e.g. Newsvine[6]), when tagging objects or content (e.g. identifying and documenting new astronomical stars for GalaxyZoo[7]) and when providing user generated videos (YouTube[8]). Contributions to the R&D activities of a firm consist of generating ideas for improved or new products (sport equipment such as basketball shoes (Füller, 2006), t-shirts and shoes[9]) or solving expert or scientific R&D problems (e.g. InnoCentive[10], Amazon Mechanical Turk[11]). In order to detect differences in motivation between operational and R&D activities, we include both activities in our study.

1.2.2. Benefits for the organizing firm

The use of online voluntary resources provides some clear benefits. A key benefit is cost savings (Howe, 2006a) since online volunteers are not rewarded in the same manner as employees. They provide their contributions frequently without being paid for it (e.g. Wu et al, 2007; Lampel and Bhalla, 2007). When financial compensation is offered, they are generally linked with contributions that represent value for the organizing company. When for example a solver provides a solution to an unsolved problem at InnoCentive, the solver gets a money prize for it varying from USD 1,000 to USD 1 million. No prize is paid when community members did not solve the problem. This makes the posting of a problem at the InnoCentive website a relatively cheap and non-risky activity. However, the story of cheap or even free resources should be tempered. The experiences of companies organizing online innovation contests show that the evaluation process can be very time and cost consuming (Jouret, 2009).

Other benefits refer to the improvement of product quality and customer intimacy and to the acceleration of development activities or large routine tasks. Quality improvement can be achieved when large numbers of users are pre-testing new products or when groups of experts are involved in forecasting (Bonabeau, 2009). Higher customer intimacy is reached through more intensive communication with online customers and increased engagement

6 http://www.newsvine.com
7 http://www.galaxyzoo.org/
8 http://www.youtube.com
9 http://www.threadless.com/ and http://www.dreamheels.com/
10 http://www.innocentive.com/
11 https://www.mturk.com/

with the product and firm when customers are contributing (Bonabeau, 2009). Acceleration of time-to-market can be realized when using external expert knowledge which is not available within the company. Proctor and Gamble wanted to boost the sales of Pringle potato chips by having them printed with trivia questions. An Italian professor had an ink-jet technology available, which could be quickly adapted for the intended use of P&G[12]. The execution of routine activities can also be accelerated through the use of large groups of volunteers. Within 4 weeks, members translated the entire content of Facebook into Spanish and within one year translation into 100 languages and dialects was achieved (Van Den Ende et al, 2009).

1.2.3. Types of organizations

New types of organizations have come into existence to organize voluntary online activities. Well known types of organizations are online communities, open source software development communities, and crowdsourcing. In this section we first provide a general description of these organization types followed by a section on similarities and differences.

Online communities

O'Mahony and Ferraro (2007) explain that a community is a social group with a shared basis of authority. Such a social group consists of people sharing common interests and needs. The specific characteristic of online communities is that members primarily interact via online communication media instead of face-to-face contacts (O'Mahony and Ferraro, 2007; Moon and Sproull, 2008).

Some authors highlight that online communities are guided by protocols and norms (Porter, 2004; Wise, Hamman and Thorson, 2006; Preece and Maloney, 2005). Frequently these protocols and norms are implemented in a formal structure that ranges from professional editors to teams of voluntary moderators (Poor, 2005; Preece, 2000). The primary function of moderators is to clarify which contributions are relevant – for example by keeping a conversation on topic – and to prevent harmful contributions. It is believed that moderation becomes more crucial when the size of an online community grows (Lampe and Resnick, 2004).

[12] http://marketing.boomja.com/index.php?ITEM=115065

Online communities use different methods to select their members (Plant, 2004; Wenger & Snyder, 2000). Although online communities usually have open-membership whereby anyone who has access to a computer and an Internet connection can become a member and participate, online communities can also use a closed-membership policy (Ciffolilli, 2003). Closed membership means that only people meeting a predetermined list of criteria are admitted. The purpose of closed-membership is to increase control over its members, making management, identification of common interests, and meeting easier (Dubé, Bourhis and Jacob, 2006). An example of a closed-membership community – or the so called gated community – is the community set up by Suncorp which is only open to carefully selected customers and non-customers; a group representing the core of the Suncorp target market[13]. An open-membership policy is more in line with the idea of using worldwide expertise and resources.

Two main types of online communities can be distinguished based on their focus: knowledge sharing communities and production communities. Communities of practice are focused on knowledge sharing (Wenger, McDermott and Snyder, 2002), while collective models of innovation can be classified as a production community (Von Hippel and Von Krogh, 2003). O'Mahony and Ferraro (2007) also acknowledge this difference in focus. In our study we consider both knowledge sharing and production communities since we would like to improve our understanding of similarities and differences between these two types of communities.

Open source communities

Originally the term 'open source' was exclusively used to describe groups of voluntary software developers at many different locations and organizations, sharing software code to develop and refine programs (Raymond, 1999; Lerner and Tirole, 2002). In recent years the meaning of the term 'open source' has broadened to groups engaged in other activities than software development. Although the activity differs, these groups of volunteers still follow one or more key characteristics of the open source software development community. Below we discuss two main characteristics.

The first characteristic concerns deviating licensing regimes. Key to open source software is a distinct class of software licenses certified by the Open Source Initiative (OSI)[14]. Such licenses must guarantee openness of the code and the rights to use, modify and distribute

[13] http://bankingreview.blogspot.com/2009/07/online-communities-innovation.html
[14] http://www.opensource.org/

the source code. In recent years, similar licenses were developed for products other than software code (e.g. creative commons licenses for art and content[15]). Despite these new licenses, in many online communities the intellectual rights are still automatically transferred to the organizer when volunteers accept the General Terms and Conditions before uploading their contribution.

The second main characteristic of open source communities is that open source developers collaborate with a common set of software tools and internet-enabled communication. Although examples of tools enabling people to co-produce or co-design (e.g. Lego Factory, c,mm,n[16]) exist, development of web-based collaboration tools is relatively premature. The majority of collaboration platforms only provide the opportunity to sign up, upload one's contribution and comment and vote on others' contributions. It is expected that in the coming years substantial efforts will be put into the development of tools which really enable collaborative design or production.

Crowd sourcing

Jeff Howe (2006a) coined the term crowdsourcing when he described a new web-based business model that harnesses the creative solutions of a distributed network of individuals. Crucial to crowdsourcing is the use of an open call format and a large network of potential laborers (Howe, 2006b). Howe further clarifies that 'it's only crowdsourcing once a company takes that design, fabricates it in mass quantity and sells it' (Howe, 2006c). It is less clear what 'mass fabrication' means in the current information society: whether it is limited to the production of physical goods or can also be extended to making information available to a large audience without any reproduction costs via the internet. We concentrate on the first part of Howe's definition of crowdsourcing focused on the outsourcing of business activities to the internet crowd via an open call.

Similarities and differences

It should be clear that online communities and crowdsourcing are not identical organizational forms. Online communities are groups in which members experience social connection. This social connection is not by definition a requirement of crowdsourcing; crowdsourcing can also be successful outside an online community. When requesting user generated ideas or designs via an open call, these are not necessarily shared with other participants. So group mechanisms applicable to community activities are not always

[15] http://creativecommons.org/

[16] http://www.cmmn.org

relevant to crowdsourcing initiatives relying on individual – and not collaborative – contributions.

After concluding that not all crowdsourcing happens in online communities, we argue that not all online communities deliver crowdsourcing. For example social networks facilitating communication between its members do not outsource activities to its members and can therefore not be classified as crowdsourcing initiatives.

We consider all open source software development initiatives as examples of crowdsourcing since software development is in general a business activity. Finally we consider open source communities as a specific form of online communities; a conclusion that we share with O'Mahony and Ferrero (2007).

In Figure 1, the relations between crowdsourcing and online and open source communities are shown. In this figure our research cases are plotted. It can be concluded that all our cases can be classified as crowdsourcing initiatives, but not all of them are online communities: participants of the Green Challenge did not form a social group that interacts via online media; they remain individual participants throughout the contest procedure. We did not include an open source case since we expect that the motivation of open source software developers is somewhat different compared to the other crowdsourcing initiatives.

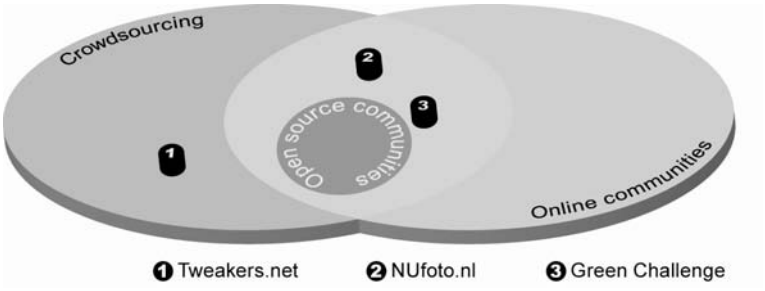

Figure 1 Relation between crowd souring – online and open source communities

1.2.4. Online voluntary resources versus employees

Online communities differ from the normal work situation in organizations with respect to the motivation of members and coordination mechanisms. In communities, expectations are not specified in contractual obligations; therefore key to participation is the contributor's self selection to assist with a task (Lakhani and Panetta, 2007). In general strong incentive schemes intended to influence self-selection are missing. In most online communities rewards are absent or small, and have the form of reputation systems on the

website or small monetary prizes for the best contributions. As a consequence members' intrinsic motivations are considered to be important stimuli of behavior (Hertel, Niedner and Herrmann, 2003; Von Krogh and Von Hippel, 2006; Dahlander and Magnusson, 2005; Shah, 2006).

In addition, reputation works out differently in an online community compared to an organization, since online communities provide a far more distributed production or knowledge sharing system (Kollock, 1999; Lakhani and Panetta, 2007; Dahlander, Frederiksen and Rullani, 2008; Brabham, 2008), in which members are often anonymous or only known by their nickname (Mesch and Talmud, 2006). It is yet unclear how in this situation extrinsic motivations and rewards affect behavior that is strongly driven by intrinsic motivation.

1.3. Research questions and design

The main objective of this thesis is to increase our understanding of how participation and performance of online volunteers can be stimulated towards the levels that the organizer desires. This requires an extension of our knowledge on the effects of motivation and rewards on behavior. Therefore the central question in this thesis is: *how do motivation and rewards affect participation and performance of volunteers in online communities?*

We expect that different motives also have different effects. Therefore we distinguish between intrinsic and extrinsic motivation. Intrinsic motivation implies that people perform an activity because they find it interesting and derive spontaneous satisfaction from the activity itself (Gagné and Deci, 2005; Calder and Staw, 1975). Extrinsic motivation implies that people perform an activity for the sake of receiving compensation or other rewards (Frey and Oberholzer-Gee, 1997; Deci, 1971).

We foresee that the effects of extrinsic motivation are conditional on the presence or absence of rewards. Although in many articles extrinsic motivation and rewards are used interchangeably, we would like to stress that these terms are not synonyms. We consider rewards and extrinsic motivation as related but not identical concepts. Motivation is a psychological feature that arouses a person to action, while rewards are the goal objectives that reinforce behavior (Porter, 1970). Thus, motivation is an internal condition while rewards are provided by external parties.

Besides the effects of the presence or absence of rewards on extrinsic motivation, we expect an interplay of intrinsic and extrinsic motivations resulting in both enhancing and undermining effects on behavior. These interaction effects are mainly expected when rewards are absent. We test which combinations of motivation levels result in positive and negative effects. Finally, we consider multiple measures of behavior: the decision to contribute, the quantity, the usefulness and novelty of contributions.

The decision to contribute is a participation measure and indicates whether the person is an active contributor or a non-contributor. Quantity, usefulness and novelty are performance criteria. Quantity is defined as an output measure, namely the number of contributions that a contributor provides in a certain time period. Usefulness is defined as the value that a contribution has for other visitors of the site or for the organizer of the crowdsourcing activity. Finally novelty means the newness of one's contribution.

The research questions underlying the central question are:

- How do intrinsic motivations of online volunteers affect the decision to contribute and the quantity, usefulness and novelty of contributions?
- When rewards are provided, how do extrinsic motivations of online volunteers affect the decision to contribute and the quantity, usefulness and novelty of contributions?
- When no rewards are provided, how do extrinsic motivations of online volunteers affect the decision to contribute, the quantity, usefulness and novelty of contributions?
- When no rewards are provided, which combinations of intrinsic and extrinsic motivation levels result in enhancing or undermining effects on the decision to contribute and on the quantity, usefulness and novelty of contributions?

We started our research with a literature review in which we identified existing theoretical models on motivation, rewards and behavior. In this review we concluded that existing motivation theories are not fully able to explain the results of empirical field studies and therefore we develop an adjusted theoretical model that we subsequently tested in our three studies. The full set of hypotheses is tested in the Tweakers.net study. The NUfoto.nl study is a replication of the Tweakers.net study in which we investigated the relevance of criteria for receiving the rewards in more detail. Finally, the Green Challenge study focuses on the effects of extreme financial rewards since the winner of the Green Challenge can earn an amount of €0.5 million.

1.4. Scientific relevance

Due to major changes in society and technology, such as increased diversity in the workforce and the use of information technology, work environments have changed dramatically. This change in work environments results in an urgent need for an adjustment of existing work motivation theories (Steers et al, 2004). We endorse that the open nature of outsourcing activities to online volunteers indeed increases the diversity of the workforce since no function requirements are specified and neither the skills nor experience of contributors are checked. We also note that crowdsourcing has changed the manner and location of work activities resulting in highly divergent needs and demands which require new theory development.

The literature on online communities has investigated the different motives of members of online communities (Lerner and Tirole, 2002; Hertel, Niedner and Herrmann, 2003; Von Krogh and Von Hippel, 2003; Dahlander and Magnusson, 2005; Shah, 2006; Jeppesen and Molin, 2003; Wasko and Faraj, 2000; Füller et al, 2007; Baldwin et al, 2006; Harhoff et al, 2003), but has left the relationship of motives to performance and the role of rewards in this relationship largely unclear. The few authors who have actually measured behavior (Wasko and Faraj, 2005; Jeppesen and Frederiksen, 2006; Lampel and Bhalla, 2007) did not find unambiguous effects of motivation since both positive and negative effects of extrinsic motives are found (Nov, 2007; Shah, 2006; Wasko and Faraj, 2005; Füller, 2006; Roberts et al, 2006). The fact that they did not take the presence or absence of rewards into account may explain the lack of consistent results. Moreover, this literature usually defines performance as just the quantity of behavior, for instance the number of hours spent on contributing to the online community or the number of contributions. This study contributes by investigating effects of intrinsic and extrinsic motivation on behavior in the presence and absence of rewards and by including multiple performance criteria, particularly the decision to contribute, and the quantity, usability and novelty of contributions. Amongst others we show that intrinsic motivation contributes to quantity and novelty of contributions, and that in the presence of rewards extrinsic motivation contributes to the usefulness of contributions.

Motivation literature by psychologists also does not provide a clear picture on how motivations and rewards affect voluntary activities or so-called free choice behavior. The end of last century saw a debate (e.g. Deci et al, 1999; Cameron and Pierce, 1994; Eisenberger and Cameron, 1996) which is still not solved. One school of scholars, advancing the Self Determination Theory, argues that rewards diminish autonomy (e.g. Deci et al, 1999; Ryan and Deci, 2000; Bear et al, 2003) and thus have negative effects on

intrinsic motivation and free choice behavior. The other school, advancing the General Interest Theory, emphasize that rewards have a signaling function regarding the importance of the task, and consequently these authors claim positive effects on intrinsic motivation and behavior (Eisenberger et al, 1998; Eisenberger et al, 1999a). Both schools support their claims with empirical evidence. Our study provides a middle ground by showing that the effects of rewards depend on a person's motivation levels. In the absence of rewards, members with a combination of high intrinsic and low extrinsic motives had improved performance and members with both high intrinsic and high extrinsic motives had diminished performance. These results indicate that the effects of rewards depend on specific combinations of intrinsic and extrinsic motivations and provide a possible solution to the debate between psychologists researching motivation for voluntary behavior.

We provide a contribution to the literature by performing a more fine-grained analysis of the relation between motives, rewards and voluntary behavior. Whereas the psychology literature has focused on the effects of rewards on voluntary behavior, we also measure the self-reported levels of intrinsic and extrinsic motivation. And whereas most of the online and open source literature just studies the motives of the contributors to online communication, irrespective of the provision of rewards (e.g. Nov, 2007; Füller, 2006; Shah 2006; Hars and Ou, 2002), we explicitly take the presence or absence of rewards into account. Moreover, both the psychology and the open source literature usually define performance as just the quantity of effort spent on the activity (e.g. Nov, 2007) or quantity of output, for example the number of creative ideas or code generated (e.g. Roberts et al, 2006). We are far more specific by analyzing the effects of motives on the decision to contribute, and on the quantity, usefulness and novelty of contributions. Finally we analyze both direct and interaction effects of intrinsic and extrinsic motives on these performance measures.

1.5. Managerial relevance

Firms using voluntary contributions aim to stimulate the participation and performance of those volunteers (Antoniadis and Le Grand, 2007; Harper et al, 2007). These firms are experimenting with rewards following classic motivation theories arguing that employees can be motivated and actively managed with rewards and that without these employees will work less effectively (e.g. Vroom 1964, 2005). From interviews with executives of firms using online volunteers, it became clear that they had not investigated which motivations are relevant for the contributions that volunteers provide (Borst and Van Den

Ende, 2007). This lack of knowledge can result in inappropriately designed reward systems with sometimes fatal consequences such as bankruptcy (Borst and Van Den Ende, 2008). Considering that firms applying this type of outsourcing, are growing into large scale and profitable companies (e.g. in 2008, iStockPhoto had a turnover of USD 130 million with a profit margin of 50%[17]), the relevance of knowledge that improves the effectiveness of these firms also increases.

1.6. Conclusion

This thesis describes the empirical testing of the effects of motivation and rewards on participation and performance of online volunteers. The selection of this topic has its origin in managerial practice: practitioners do not have solid knowledge on which motives drive the behavior of online volunteers and the effectiveness of rewards in active management of online volunteers. The topic also appears to be a research challenge since online and open source researchers have hardly investigated the *effects* of motivation on the behavior of online volunteers and have not explored the effects of reward systems. Psychology researchers on motivation for voluntary behaviour have been debating the effects of motivation and rewards for more than a decade. We will provide a contribution to both literature streams by performing a more fine-grained analysis of the effects of intrinsic and extrinsic motivation and rewards on participation and performance.

1.7. Reader guide

In Chapter 2, we start with a review of motivational literature. We review papers on motivation in online and open source communities and psychology literature on motivation for voluntary behavior. This literature review forms the basis for our theoretical model that we tested with three empirical studies. The development of our theoretical model and underlying hypothesis is described in Chapter 3. In Chapter 4 the general research design that we followed in our three studies is described. Case specific methodologies are not described in this chapter, but are included in the chapter of each specific study. The three studies are extensively described in Chapters 5 to 7. Chapter 5 is dedicated to the study of Tweakers.net, Chapter 6 to NUfoto.nl and Chapter 7 to the Green Challenge 2008. Per

[17] http://www.ethanzuckerman.com/blog/2009/03/17/jeff-howe-on-crowdsourcing/#comments

study, the research context, study specific methodologies, results and conclusions are reported. In the last chapter, Chapter 8, we present a summary of our conclusions.

Chapter 2. Literature Review: Motivation Theories

2.1. Introduction

In this chapter, we first provide a description of motivation theories that explain behavior in online or open source communities. Although a substantial number of scientific articles address this topic, motivation theories for voluntary online behavior are barely developed. In order to form a proper theoretical foundation for our studies, we also consider motivational theories developed by cognitive psychologists explaining voluntary behavior in offline situations. In particular we describe the Cognitive Evaluation Theory, the Self Determination Theory and the General Interest Theory.

2.2. Motivation in online and open source literature

2.2.1. History and status

Since the turn of the century an impressive body of academic research on online and open source communities has emerged. Von Krogh and Von Hippel (2006) suggest a framework for organising the existing research papers. They distinguish three research areas: the organisation process, competitive dynamics and the motivations of contributors. The first research area focuses on the governance and other organisation issues such as leadership. The second group of researchers explores the impact of voluntary contributions to online and open source communities on competition with traditional firms. Finally the topic of motivation appears as a separate research area. It appears that a large number of studies deal with the question “what makes individuals voluntarily participate in online and open source communities?” Most researchers performed explorative research, identifying motives for participation. A limited number of researchers also performed quantitative research by actually measuring motivation levels. Finally, theory development embraced empirical results (Von Krogh and Von Hippel, 2006). These three types of motivation studies are discussed below.

2.2.2. Identified motives

A major number of explorative motivational studies are performed in open source communities (e.g. Lakhani and Wolf, 2005; Shah, 2006; Hars and Ou, 2002) although some other online communities are studied as well; for example communities engaged in computer game development (Jeppesen and Molin, 2003), knowledge sharing (Hars and Ou, 2002) and the design of basketball shoes (Füller et al, 2007). When clustering these motives into intrinsic and extrinsic motivations – note that researchers did not, in general, cluster the motives themselves – these exploratory studies appear to have similar findings. As expected for voluntary activities, intrinsic motives, such as fun and learning play, an important role, but these were not the sole reason for participation since extrinsic motives also appear to be relevant. A mix of intrinsic and extrinsic motives determines the participation of online volunteers. The main extrinsic motive found to be relevant for voluntary online contributions is peer recognition (Hars and Ou, 2002; Jeppesen and Molin, 2003: Wasko and Faraj, 2000; Lerner and Tirole, 2002, Lakhani and Wolf, 2005; Shah, 2006). Peer recognition includes the signaling of competencies by colleague experts.

In addition to the motives of fun, learning and recognition, research on open source communities identified a limited number of very specific motives: the motive 'desire to satisfy own needs' (Franke and Von Hippel, 2003; Lakhani and Von Hippel, 2003; West and Gallagher, 2006) and pro-social feelings, such as altruism. The desire to satisfy own needs can be classified as extrinsic motivation while the pro-social feelings are part of one's intrinsic motivations.

The desire to satisfy own needs refers to the situation in which a software developer solves their own problem and subsequently reveals his or her solution to the community. In our view the desire to satisfy own needs explain why the person develops the software code, but not the subsequent step to reveal it to the community. Motives such as recognition and reciprocity expectancy ('tit for tat') are more likely to explain the uploading and publishing of self-produced code. We argue that this motive, desire to satisfy own needs, is more applicable in communities were design and production of goods and materials are separated, in other words where a consumer can not take care of the production him/herself. When you for example want to buy a personalized toy, you can send your own design to the producer to satisfy your need. Again other motives, such as recognition for your design skills and the desire to receive a revenue share of the sales from your design, become relevant when placing your design in a catalogue of the producer so that other customers can also order this toy (e.g. Lego Factory).

Pro-social motivations or altruism can be described as the desire to increase the welfare of other people or the obligation to do something for another at the costs of oneself (Ozinga, 1999). Pro-social motivations are classified as intrinsic motivation since these feelings of obligation arise in the person him/herself. Pro-social motivations are found to be relevant in communities such as Wikipedia (Nov, 2007) or a community of legal experts providing free advice (Franke and Shah, 2003). Again, this type of motivation is not relevant for all online voluntary contributions since some contributions do not increase the welfare of visitors. For example a person uploading entertainment videos on YouTube is not expected to experience altruistic feelings. Feelings of recognition are expected to be far more relevant for uploading video clips.

Therefore we conclude that the motives 'desire to satisfy own needs' and pro-social motivations are not always applicable in online contexts.

2.2.3. Quantification of motivation

While the majority of explorative studies rely on indirect methods for analysing motivation, for example through an analysis of weblogs and posts or through interviews of product development managers organizing the community activities (Jeppesen and Molin, 2003; Füller et al, 2007), most quantitative studies measure motivation at the source, namely through websurveys among the contributors. Filling in the websurvey require respondents to score their own motivation on a Likert scale. These studies show that the average level of intrinsic motivation of online volunteers is substantially higher than their extrinsic motivation (Nov, 2007; Wasko and Faraj, 2005) sometimes even twice as high (Füller, 2006). It should be noted that these studies do not analyze the motivation levels in relation to the presence or absence of rewards.

Even more interesting are those studies that explore how motives produce a mix of outcomes. This exploration requires the measurement of not only motivation, but also performance. We observe that the performance measure, quantity, is the most frequently investigated. The following table shows the findings of studies on the relation between motivation and the performance measure, quantity. Effects found appear to be inconsistent.

Table 1 Effects of motivation on quantity of contribution in online literature

Author(s)	Quantity definition	Intrinsic motives		Extrinsic motives	
		Pleasure	*Challenge*	*Desire for compensation*	*Desire for recognition*
Füller (2006)	Self reported future contributions	**Positive Effect**	**No Effect**	**Positive Effect**	**No Effect**
Nov (2007)	Self-reported hours spent per week	**Positive Effect**	**Positive Effect**	Not studied	**Positive Effect**
Shah (2006)	Self reported participation level	**Positive Effect**	Not studied	Not studied	**Negative Effect**
Wasko and Faraj (2005)	Number of messages posted	**No Effect**	Not studied	Not studied	**Positive Effect**
Lampel and Bhalla (2007)	Number of online reviews contributed	Not studied	Not studied	Not studied	**Positive Effect**
Roberts et al (2006)	Number of source code contributed and accepted	**No Effect**	Not studied	Not studied	**Positive Effect**

The most remarkable are the contrary effects of the motive 'desire for recognition' on the number of contributions; both positive (Nov, 2007; Wasko and Faraj, 2005; Füller, 2006; Roberts et al, 2006) and negative effects are found (Shah, 2006). Furthermore, Shah (2006) and Lakhani and Wolf (2005) find positive effects of the motive pleasure on quantity while results of another study do not confirm these effects (Roberts et al, 2006).

One might expect that differences in measurement methods, i.e. subjective self-reported measures versus objective count data (see second column in which the quantity definition is described), explain the contrary findings. You could argue that numbers of self-reported quantities are more optimistic and studies using these quantity measures found more positive effects than actual measures of quantity. This does not appear a valid assumption since Shah (2006) who used a self-reported measure found negative effects of recognition while studies using objective quantity measures report positive effects. The studies using self-reported measures of quantity even show the highest inconsistency in the effects of recognition. Therefore the measurement methodology does not explain the contrary findings.

Another possible explanation could be the presence or absence of reputation systems rewarding a contributor for high quantity. The motive, desire for recognition, may work out differently when reputation systems are absent and needs are not satisfied compared to the presence of reputation systems. The researchers do not indicate whether reputation systems were present or absent, which severely hinders the interpretation of the results. In our

studies we analyze the effects of motivation on behavior with both the presence and absence of rewards.

To our knowledge, only two studies address performance measures other than the quantity of contribution. Wasko and Faraj (2005) determined the helpfulness of answers to legal questions based on an interpretation of response messages and found that only the motive, desire for reputation, has a positive effect on quality. Jeppesen and Frederiksen (2006) measured the self-reported innovativeness of contributions and concluded that striving for firm recognition increases the innovativeness of contributions. It should be noted that researchers did not include all intrinsic and extrinsic motives in their studies, so we do not gain a complete picture of the effects of intrinsic and extrinsic motives.

2.2.4. Motivation theories for online behavior

Some theorists have tried to explain online behavior with the help of existing organizational models that also include motivation. Von Hippel and Von Krogh (2003) for example tried to apply the private investment model and collective action model to online contexts.

The private investment model assumes that people or organizations put time, money and other resources into an innovation because they expect a private return (Demsetz, 1967). It is clear that in an open source project, in which the software developer freely reveals his software code, no private returns are present. The collective action model is typically described as the collective that produces a public or semi-public good. Public goods are defined by their non-excludable and non-rival nature (Von Hippel and Von Krogh, 2003; Wasko et al, 2009). This means that even if a user consumes this public good, it is also open for consumption by other users. Examples of public goods are public roads and parks, national defense, clean environment and a crime-free neighborhood. Von Hippel and Von Krogh (2003) argue that the Public Action model is not applicable to open source projects because members in open source projects have the option to wait for others to contribute and then free-ride on what they have done. It appears that members of open source communities are not stopped by the chance of free-riding. So in the Public Action Model the question still remains as to why people en masse freely reveal their software code or other types of innovations (Lerner and Tirole, 2002).

Von Hippel and Von Krogh (2003) introduced the Private-Collective model which is a compound of the Private Investment and Collective Action Model. They suggested that the Private-Collective model would provide the ‘best of both worlds’, by combining the

benefits of the two models. They showed that the application of the Private-Collective model is not limited to open software development, but also applies to the free revelation of product and service designs (Von Hippel and Von Krogh, 2006). They defined free revelation in a broad sense to include the absence of immediate financial compensation for one's contribution: the voluntary sacrificing of all intellectual property rights of that design and providing all parties equal access it. They consider free revelation a defining characteristic of open innovation (Von Hippel and Von Krogh, 2006).

In the Private-Collective model, innovators use their own resources to privately invest in creating product or service innovations. First, the model highlights that, in general, the competitive advantage associated with keeping the code private is relative low. The commercialization process of their developed software is often times very time consuming and very costly (e.g. applying for intellectual property rights), which limits the chance for profits (Von Hippel and Von Krogh, 2003, 2006). In addition Von Hippel and Von Krogh (2006) suggest that some of these innovations are created at low costs, which also strengthen the willingness to freely reveal it. Finally, contributors gain some benefits that are not applicable to the free riders. Contributors retain private benefits, such as learning and enjoyment, and benefits associated with community participation, such as social rewards and feelings of solidarity, altruism, fairness and the like (Von Hippel and Von Krogh, 2003, 2006). These benefits are expected to offset the absence of direct or possible future monetary rewards.

The Private-Collective model thus shows that most innovators have difficulties personally commercializing their innovation which positively affects the willingness to freely reveal the innovation. Furthermore, this willingness to share the innovation with others is strengthened through its low investment. Ultimately, this mix of non-monetary motives yields a rationale for freely revealing the innovation. Although the Private-Collective model acknowledges that a mix of motives is relevant for freely revealing one's contribution, it does not specify the relative importance of types of motives. Our research deals with a more specific level of motivations. Finally, we argue that the Private-Collective model is not applicable to all crowdsourcing initiatives since some initiatives provide financial compensation. In the crowdsourcing initiatives where financial compensation is offered, one can not speak of the free revelation of work by volunteers.

2.3. Motivation theories in cognitive psychology literature

Empirical studies on online communities show contrary effects of motivation on the quantity of contributions which may be explained by presence or absence of rewards. The possible effects of rewards are not addressed in the literature on online communities. A large numbers of psychologists studied the effects of rewards in other contexts, namely in laboratory experiments with rewarded and non-rewarded groups that had to perform the same activity. A comparison of intrinsic motivation, i.e. task interest, and performance between the rewarded and the non-rewarded control group resulted in conclusions on the effects of rewards. Due to mixed results, two schools of thought came into existence. The two schools agree that the presence of rewards affects behavior, but they do not agree whether the effects are positive or negative (Cameron et al, 2001).

The first school of thought consists of researchers supporting the general hypothesis that expected tangible rewards made contingent upon doing, completing or excelling at an interesting activity undermine intrinsic motivation for that activity. They base their hypothesis on four meta-analyses (Rummel and Feinberg, 1988; Wiersma, 1992; Tang and Hall, 1995; Deci, Koestner and Ryan, 1999). The undermining effect of rewards on intrinsic motivation and behavior is theorized in the Cognitive Evaluation Theory (CET) which was later extended into the Self Determination Theory (SDT).

The second school of thought consists of researchers claiming that expected tangible rewards do not have undermining effects under all circumstances (Eisenberger and Cameron, 1996; Cameron and Pierce, 1994). This school argues that rewards can have neutral or even positive effects on intrinsic motivation and behavior. Their views are theorized in the General Interest Theory (GIT).

These three different motivation theories (CET, SDT and GIT) are described in the following sections.

2.3.1. Cognitive Evaluation Theory

Deci and Ryan were the key developers of the Cognitive Evaluation Theory (CET) (Deci, 1971; Deci and Ryan, 1985; Amborse and Kulik, 1999). The basis of CET is that individuals assess whether the execution of a task meets and fulfills basic psychological needs (the so called: cognitive evaluation). The CET specifically focuses on contextual factors of a task, such as monetary rewards, punishments, verbal reinforcements (positive and negative feedback) and deadlines. When contextual factors satisfy a person's needs,

these context factors have a positive effect on the person's intrinsic motivation and the person will be engaged in this activity. When contextual factors do not satisfy a person's need, a negative effect on the individual's intrinsic motivation and subsequently his or her behavior will occur (Deci, 1972). This is visualized in Figure 2.

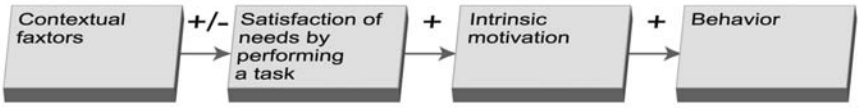

Figure 2 Impact of contextual factors on intrinsic motivation and behavior according to CET

Deci and Ryan (2002) suggest that in the cognitive evaluation three psychological needs are relevant: need for autonomy, need for competence and the need for social relatedness. These three needs will be discussed in the following sections.

Need for autonomy

The term autonomy refers to regulation by the self (Ryan and Deci, 2006) or to put it more simply: the extent to which a person his/herself can determine his/her behavior. The terms autonomy and self-determination are used interchangeably in the literature. The opposite of autonomy is heteronomy and refers to controlled regulation or regulation that occurs without self-endorsement (Ryan and Deci, 2006).

It is recognized in the economic literature that autonomous functioning makes people more engaged and productive (e.g. Frey and Stutzer, 2002). Consistent with this line of thinking, some studies show that higher levels of autonomy positively influence intrinsic motivation (e.g. Deci, Koestner and Ryan, 1999), performance (e.g. Baard, Deci and Ryan, 1998) and creativity (e.g. Amabile, 1983).

According to CET, contextual factors have an effect on the level of autonomy that people experience. Examples of factors that constrain autonomy are social controls, evaluative pressures, rewards and punishments. Contextual factors that have a positive effect on autonomy are choice and opportunities for self-direction (Deci and Ryan, 1985).

CET speaks of a controlling context factor when this context factor has a negative effect on perceived autonomy (Deci 1971; 1972). A controlling contextual factor occurs when the recipient feels forced to act in a particular manner or feels pressure to attain a particular behavioral outcome (Ryan, 1982). The CET posits that monetary rewards make a person feel persuaded to achieve a particular outcome which negatively affects his/her perceived level of autonomy. The controlling effects occur only when rewards are expected and when

rewards are engagement contingent, completion contingent and performance contingent (Deci et al, 1999b). Completion contingent rewards require that the person completes the task before receiving the reward, while engagement contingent rewards are dependent on engaging in the task, but do not requiring completion. In case of performance contingent rewards, receiving the reward is linked to a person's performance. The level of perceived control is the lowest for engagement contingent rewards followed by completion contingent rewards. The level of perceived control is the highest for performance contingent rewards.

Need for competence

Deci and Ryan concluded that the need for autonomy was not sufficient to explain effects of contextual factors found in multiple laboratory experiments and introduced a second relevant psychological need: the need for competence (Deci, 1972; Ryan, 1982). The need for competence can be understood as the psychological need of an individual for confirmation of one's self-esteem. When people's perceptions of their own competence increase, their intrinsic motivation will increase (Deci, 1971; Arnold, 1976).

Contextual factors influence a person's perceived competence when the factors provide information about his/her competence (Ryan, 1982). Examples of informational contextual factors are performance feedback and explicit competition which leads to a distinction between winners and losers. Contextual factors can have enhancing or diminishing effects on perceived competence: positive feedback will signify one's perceived competence, while negative feedback signifies incompetence. In effect, not winning a reward can be considered negative feedback and can therefore have a negative effect on one's perceived competence.

Ryan (1982) argues that the need for competence is relevant only in situations in which the controlling aspect is relatively non-salient. This means that the informational aspect is only relevant when controlling context factors are absent. This conclusion is based on a field study in which monetary rewards were provided. It appeared that the informational aspect of context factors did not influence the undermining effects of the financial rewards (Fisher, 1978). According to CET, performance contingent monetary rewards are always considered to have a strong controlling aspect; so for those rewards an assessment of the informational aspect appears to be irrelevant.

Need for social relatedness

The third basic psychological need that CET distinguishes is the need for social relatedness (Ryan and Deci, 2000). The need for social relatedness can be understood as the need for a warm, caring and secure environment during the execution of the task. Persons with higher feelings of social relatedness are expected to be show higher intrinsic motivation.

CET hypothesizes that context factors have an impact on feelings of social relatedness. For example when teachers are ignoring their students and do not respond to students' initiatives, the need for social relatedness is not satisfied. In such a situation lower intrinsic motivation is observed (Anderson, Manoogian and Reznick, 1976; Ryan and Grolnick; 1986) while contexts providing a secure relational base increase intrinsic motivation (Frodi, Bridges and Grolnick, 1985). Although CET scholars acknowledge that many intrinsically motivated behaviors are happily performed in isolation, they consider a secure relational base as important for achieving the level of intrinsic motivation (Ryan and Deci, 2000). Therefore a secure relational base will make it more likely that this person will engage in the task.

CET does not explicitly mention whether a secure relational base still influences intrinsic motivation and behavior in situations where controlling contextual factors are present. Based on CET's overall conclusion that financial rewards always have an undermining effect, we conclude that the effects of need for autonomy overrule the positive effects of a secure relational base.

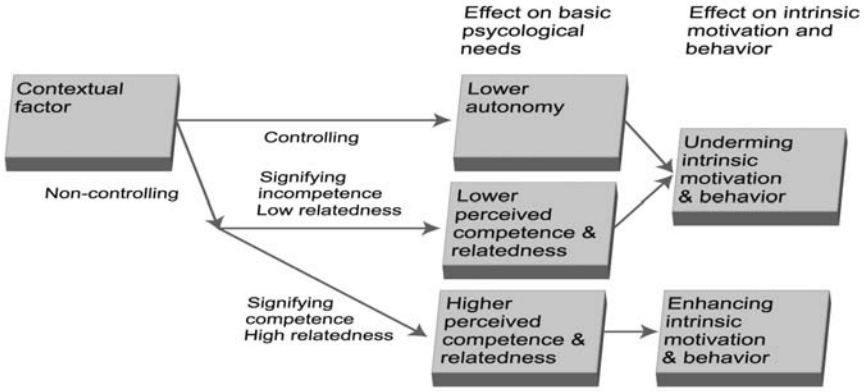

Figure 3 Application of Cognitive Evaluation Theory

Figure 3 shows our interpretation of how the effects of contextual factors on intrinsic motivation and behavior should be determined according to CET. The first step is to determine what the effect of a contextual factor on autonomy is or in other words: whether

the context of the task should be perceived as controlling or non-controlling. According to the CET a controlling contextual factor will always decrease the perceived autonomy and as a consequence has an undermining effect on intrinsic motivation and behavior. No further assessment is needed in this case. When the context is perceived as non-controlling, an assessment of the effects on perceived competence and social relatedness is required. Dependent on whether the context factor signifies (in)competence and relatedness, perceived competence and relatedness increase or decrease and as a consequence undermining or enhancing effects on intrinsic motivation and behavior occur.

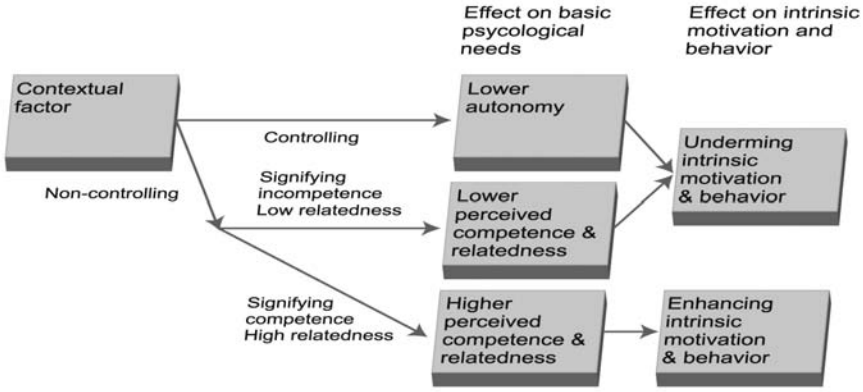

Figure 4 Application of Cognitive Evaluation Theory

CET is not clear on how opposing informational and social relatedness effects should be weighted. CET emphasizes that financial rewards are always perceived as controlling and have an undermining effect.

It should be noted that when CET (but also SDT and GIT) speaks of financial rewards, performance contingent rewards are meant. This means that financial rewards are only granted when a participant fulfils certain performance criteria or meets or exceeds the performance of other participants (see Annex A for a typology of reward contingencies).

Field studies in various domains such as sports (e.g. Frederick and Ryan, 1995; Vallerand and Reid, 1984) and educational settings (e.g. Mandigo and Holt, 2000) test and extend CET.

2.3.2. Self Determination Theory

The Self Determination Theory (SDT), also developed by Deci and Ryan, can be considered as an extension of CET (Ryan and Deci, 2000). SDT does not solely focus on intrinsic motivation, but also other recognized motivational types including extrinsic motivation. SDT provides a taxonomy of motivational types on the basis of a level of self-determination. Each motivation type has specific consequences for behavior, performance and well-being.

All motivation types are placed on a continuum of self-determination level. According to SDT intrinsic motivation is truly self-determined, extrinsic motivation is to a lesser extent self-determined and amotivation is fully non-self-determined. Unlike other perspectives, that consider extrinsically motivated behavior as invariantly non-autonomous, SDT proposes that extrinsic motivation can vary greatly in its relative autonomy. SDT distinguishes four forms of extrinsic motivation differentiated by the level of autonomy. The least autonomous extrinsic motivation is called external regulation. Introjected, identified and integrated regulations are other extrinsic motivation forms with increasing levels of autonomy. Figure 5 illustrates the place on the self-determination continuum, followed by a description of each motivation type.

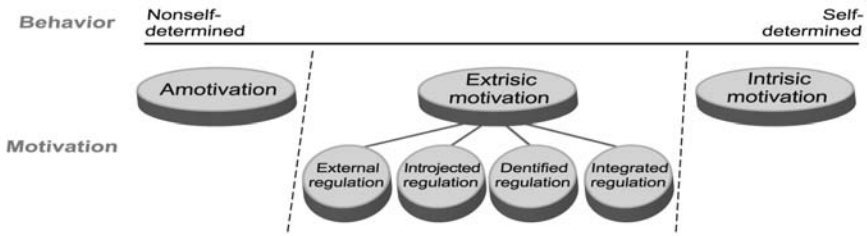

Figure 5 The Self-Determination Continuum (Ryan and Deco, 2000)

- *Amotivation* is a state of lacking the intention to act and results from not valuing an activity, not feeling competent to do it or not expecting it to result in a desired outcome. It is positioned as the most non-self-determined type of motivation.

- *External regulation* is the least autonomous extrinsic motivation. Such behaviors are performed to satisfy an external demand or reward contingency. Persons experience externally regulated behavior as controlling. External regulation is typically contrasted with intrinsic motivation in many laboratory and field studies.

- *Introjected regulation* involves taking in a regulation but not fully accepting it as one's own. This type of behavior is performed to avoid guilt or anxiety or to attain ego enhancements such as pride. Examples of introjected motivation include people that have the desire to demonstrate their abilities to gain or maintain feelings of value.

- *Identified regulation* reflects an evaluation of a behavioral goal such that the action is accepted and owned as personally important.

- *Integrated regulation* occurs when identified regulations are fully assimilated to the self. This means that these regulations are consistent with a person's values and needs.

- *Intrinsic motivation* is the natural inclination toward assimilation, mastery, spontaneous interest and represents a principal source of enjoyment and vitality (Csikszentmihalyi and Rathunde, 1993; Ryan, 1995).

Consistent with CET, SDT argues that perceived autonomy has a more positive effect on behavior: the chance that a person will carry out the activity increases when the person experiences a higher level of autonomy and the behavioral quality is also positively affected (Ryan and Deci, 2000). Since SDT places intrinsic and extrinsic motivations on a continuum of autonomy where intrinsic motivation has the highest level of autonomy, this automatically implies that intrinsic motivation is expected to lead to higher levels of activity and higher quality of behavior than all types of extrinsic motivation. Correspondingly, integrated regulation is expected to lead to higher levels of activity and higher quality of behavior than the other forms of extrinsic motivations although less so than intrinsic motivations.

SDT also argues that greater internalization and integration can be achieved by shaping the right context. SDT researchers found that contexts supportive of autonomy, competence and relatedness foster greater internalization and integration than contexts that do not satisfy these needs. Thus, persons can be motivated in a way that engenders commitment, effort and high quality performance when a social context is created that is responsive to basic psychological needs – self-determination, competence and relatedness. On the other hand, excessive control, non-optimal challenges and lack of connectedness are factors that result in a lack of initiative and responsibility and also in distress (Ryan and Deci, 2000). We conclude that SDT argues that extrinsic motivated behavior, just like intrinsic motivation, is enhanced or hindered by contextual factors.

2.3.3. General Interest Theory

Eisenberger, Pierce and Cameron (1999) introduced the General Interest Theory (GIT). Similar to CET/SDT, GIT argues that contextual factors influence intrinsic motivation and behavior. Whereas CET and SDT specify that contextual factors can have an influence on three psychological needs, GIT focuses on only one: the relevance of the task. The relevance of the task is defined as the level that task content or task context helps satisfy needs, wants and desires. Psychological needs such as the need for autonomy and competence are included in this definition, but also other needs such as the desire to provide novel contributions, the desire to identify with the task giver's judgment of the task or with one's peers. Therefore GIT's assessment of the effects of contextual factors on intrinsic motivation and behavior is broader than CET/SDT.

Although GIT argues that more psychological needs are relevant in explaining intrinsic motivation, in the discussion on the effects of rewards, only the influence on the need for autonomy and competence are addressed. GIT disagrees with CET/SDT that rewards always have a negative effect on perceived autonomy and also disagrees that rewards do not have an effect on perceived competence (Eisenberger et al, 1999b; Cameron et al, 2001).

GIT posits that rewards can have a positive effect on perceived autonomy and therewith have a positive effect on intrinsic motivation and behavior. GIT argues that the offering of a reward confirms that the reward-giver does not have control on the person to do the activity and instead must create beneficial circumstances to convince this person to do the job. In this way the reward makes the person more conscious that he or she can decide him- or herself to engage in the activity. Therefore the reward increases perceived autonomy. In this argumentation GIT follows Pryor (1985, page 172) who states that when a person receives information about how the reward giver would like the reward recipient to perform, this person can then control the environment. This means that the reward recipient has the option to decline the reward and by not acting as requested. A lab experiment with college students (Eisenberger, Roades and Cameron, 1999) showed that rewarded persons had higher perceived autonomy and spent more free time on the activity. Therefore evidence was provided for the proposition that rewards can have a positive effect on perceived autonomy and intrinsic motivation (Eisenberger et al, 1999a).

As mentioned above, GIT also disagrees with CET and SDT in that financial rewards have no effect on perceived competence. GIT argues that rewards can have both negative and positive effects on perceived competence. A negative effect occurs when rewards are

offered for trivial activities or when the reward criteria are formulated vaguely. A positive effect is foreseen for performance contingent rewards since those rewards confirm one's competence. Rewards for surpassing others especially increase perceived competence, because they make individuals believe that they are competent or self-efficacious (Eisenberger et al, 1999a). Multiple studies confirmed a positive relationship between performance contingent rewards and perceived competence and intrinsic motivation (Bandura, 1997; Harackiewicz et al, 1987).

Application of GIT

In contrast to CET and SDT, GIT is able to explain both negative and positive effects of rewards on intrinsic motivation. Furthermore it is important to note that GIT does not limit itself to tasks having high initial interest. In GIT's view it is important to also include tasks having low initial interest. Interest in tasks that require considerable skill (e.g. learning a new language) will initially be low because it takes some time before a person improved his or her skills; the initial uninteresting task then becomes more interesting. Therefore GIT argues that ways of presenting tasks that convey their relevance or irrelevance of need satisfaction, including the use of reward, should influence intrinsic interest in initially less interesting as well as more interesting tasks. Therewith GIT claims a broader application compared to CET/SDT which only includes interesting tasks (Eisenberger et al, 1999b).

2.3.4. Illustrative studies

Based on the previous paragraphs it is clear that GIT scholars and CET/SDT scholars have contentious opinions on the effects of rewards. The two schools of thought base their theories on a large number of laboratory experiments (more than 100 studies). Although we do not pretend that we redid the four meta-analyses, we conclude that the studies underlying the theories are quite diverse and in some aspects incomparable. In order to illustrate this, we describe two studies. The first study concludes that rewards have undermining effects and the second study shows the opposite. Both studies are focused on the same reward type, namely performance contingent rewards.

Lab experiment finding undermining effects of rewards

The lab experiment of Enzle, Roggeveen and Look (1991) evaluates the effects of rewards on the amount of time that people voluntarily play a game. Participants of this experiment were 54 university students. The set-up of the experiment consisted of a preparatory phase and a phase in which free choice behavior was measured. In the preparatory phase participants were randomly divided in two groups, each group had specific experiment conditions.

- *Rewarded group.* These participants were informed that they could earn $3 by making complex patterns of words during a crossword game. After the game, some participants would be asked to assess the complexity of his or her word patterns themselves and to decide whether payment was justified or not. For other participants the experimenter would decide on the complexity of the word patterns and on whether or not the participant should receive the $3.

- *Non-rewarded group.* The instructions for this group of participants included only the request to play the crossword game. After the instruction, participants had to play the crossword game until the experimenter notified that it was finished. The rewarded groups received the $3 when they or the experimenter indicated that they had sufficiently complex word combinations. The non-rewarded group did not receive the envelope with the money. Next the experimenter commenced a 10-minute period in which he measured the free time spent on the game through observation.

It appeared that being rewarded in the preparatory phase undermined the behavior in the free play period: rewarded participants spent less free time on the game. In the metastudy (Deci et al, 1999), the results of this study contribute to the conclusion that financial rewards have undermining effects. It should be noted that in this experiment the measurement of performance (i.e. time spent in the free play period) in the time period for which the reward was applicable. In addition, receiving a reward may cause that rewarded participants are bothered by other issues – such as thinking whether the reward is justified, how they are going to spend the money – which substract attention from playing the game in the free play period. Therefor we argue that this experiment does not have the right design for measuring the effects of performance contingent rewards.

Lab experiment finding enhancing effects of rewards

The lab experiment of Eisenberger and Rhoades (2001, study 3) evaluates the effects of expected rewards on creative performance. Participants of the experiment were 115 college students enrolled in an introductory psychology course. The experiment was presented as a class project. Participants received the instruction to list five creative titles for a short story and to write these on an A4 with 5 horizontal lines. Half of the participants received with their printed instruction, the promise of a reward for creative performance while the other half did not get this promise. Three research assistants assessed the creativity performance of the titles by assigning a score from 1 (little or no creativity) to 5 (highly creative) to each title. In this experiment it was concluded that the promise of reward increased the performance.

In this experiment participants had to participate because it was part of their psychology classes. It could be questioned whether the design of this experiment allow for conclusions on voluntary behavior.

While the second study measured the direct effect of being rewarded, the first study addressed the effects of being unrewarded after a rewarded situation. Although the studies exhibit different experimental designs, the results are used in the same discussion: whether rewards have an impact on intrinsic motivation and behavior. In addition we emphasized our comments on the experiment designs.

2.3.5. The reward-performance controversy

CET/SDT and GIT scholars have fundamentally different views on the effects of rewards and what explains contrary empirical findings. The two groups of scholars published a stream of articles discussing their contentious opinions (Eisenberger, Pierce and Cameron, 1999; Carmeron, 2001; Cameron et al, 2001; Deci et al, 2001a; Deci et al, 2001b; Cameron and Pierce, 2006; Ryan and Deci, 2006). The contention is mainly focused on the effects of performance contingent rewards.

In this discussion, Deci and their sympathizers have two main arguments. Firstly, they deny findings that show positive effects of performance contingent rewards (Deci, Ryan and Koestner, 1999a; 199b). They accuse the meta-studies showing positive effects of rewards (Cameron and Pierce, 1994; Eisenberger and Cameron, 1998; Eisenberger et al, 1999; Cameron et al, 2001) of methodological errors, for example using inappropriate control groups, improper measures of intrinsic motivation and invalid experimental conditions. Secondly, they argue that the inclusion of studies assessing non- or low-interesting activities is incorrect since people performing these tasks do not have any intrinsic motivations. They argue therefore that reward effects can not be examined since there was no intrinsic motivation to be destroyed (Deci et al, 2001b). Thus CET/SDT scholars do not accept the conclusions of the GIT scholars based on methodological and theoretical grounds and deny any positive effects of rewards. We question whether this position can be sustained since newly performed field studies show enhancing effects of rewards in interesting activities (Campbell and Niles, 2006; Kuvaas, 2006; Theivantanthampillai et al, 2008).

GIT scholars parry the methodological criticism of CET/SDT scholars and do not agree with CET/SDT's conclusion that financial rewards always have undermining effects. They acknowledge the contradictory effects of rewards on intrinsic motivation and performance

(Cameron et al, 2001). They argue that differences in performance contingent rewards cause differences in effects on intrinsic motivation and behavior. When, for example, a reward is granted to a single winner (i.e. one participant should surpass all other participants) different effects can be expected as compared to a situation in which all participants who are doing well receive a reward.
Table 2 shows the effects of different types of performance contingent rewards on intrinsic motivation and behavior.

Table 2 Comparison of effects of tangible rewards in high interest tasks (Cameron, 2001)

Deci et al, 1999	Effect on intrinsic motivation (task interest)	Effect on free choice behavior	Cameron et al, 2001	Effect on intrinsic motivation (task interest)	Effect on free choice behavior
Performance contingent reward	***No Effect***	***Decrease***	*Rewards offered for each unit sold*	***Increase***	***Decrease***
			Rewards offered for doing well	***No Effect***	***Decrease***
			Rewards offered for surpassing a score	***Increase***	***No Effect***
			Rewards offered for exceeding others	***Increase***	***Increase***

Cameron (2001) concludes that positive effects are obtained when tangible rewards are explicitly tied to performance standards and to success. Negative effects are produced when these rewards signify failure or are loosely tied to behavior. She emphasizes that this conclusion applies to both interesting and non-interesting tasks. The refinements provided by Cameron are not in line with results by recent studies. For example a recent study of Eisenberger and Aselage (2009) showed that rewards for doing well, increase both task interest and free choice behavior. Therefore we conclude that other explanations are required to solve the controversy.

2.4. Conclusion

Empirical studies of online communities do not show unambiguous effects of motivation on performance. We argue that contrary results may be explained by the presence or absence of rewards. Therefore we contribute to the literature by including an analysis of reward systems in our study. We also extend the literature on online communities through our analysis of multiple performance measures instead of a single measure. We also examine the motivations of non-contributors which provide insight into relevant motives for the decision to contribute.

Cognitive psychologists that studied intrinsic motivation and behavior in offline contexts dispute the effects of rewards. While CET/SDT scholars argue that financial rewards always have an undermining effect on intrinsic motivation and behavior, GIT scholars argue that financial rewards can also have enhancing effects. We highlighted some methodological concerns that are the basis for the controversy between these two schools of cognitive psychologists and indicated that new field studies suggest that arguments used in the controversial discussion do not hold.

Chapter 3. Theoretical Framework

3.1. Our approach in resolving the controversy

Despite lengthy discussions, CET/SDT and GIT scholars appear to be incapable of explaining the different effects of rewards. We disagree with the CET/SDT scholars who only acknowledge the undermining effects of financial rewards since new field studies, undertaken after the debate in 1999 – 2002, show that financial rewards can also have positive effects on intrinsic motivation and behavior. We do not agree with the explanation provided by GIT (Cameron, 2001) implying that the performance outcomes are dependent on the type of performance contingent financial rewards, since new field studies do not confirm these hypothesized effects.

We formulate a new approach which should explain the undermining, enhancing and neutral effects of financial rewards. Our approach is based upon three new elements that we add to the motivation theories of the cognitive psychologists. These three elements are discussed below.

Effect of extrinsic motivation

Both CET and GIT scholars study free choice behavior. Both schools of thought assume that voluntary behavior in these studies is mainly determined by intrinsic motivation, particularly when no rewards are offered. We disagree with this proposition and would like to emphasize that when no rewards are offered, we still expect that extrinsic motivation affects a person's behavior. In our view, a motivational orientation in a specific situation is not primarily influenced by rewards but by the appreciation attitude of the person of this type of activity and by his or her general and rather stable motivation orientation (Vallerand, 1997; Guay et al, 2000; 2003; Ratelle et al, 2005). Vallerand (1997) introduced the Hierarchical Model of Intrinsic and Extrinsic Motivation in which three layers of motivation are depicted: global motivation, contextual motivation and situational motivation. Global motivation is part of one's personality and determines one's general motivation orientation for example a generic preference for receiving financial rewards. Contextual motivation indicates a person's motivation orientation in a specific context or life domain; for example motivation for sport activities. Finally, situational motivation refers to a person's motivation orientation in a specific situation; for example motivation in a specific football match. An important element of the Hierarchical Model is the top-down effect of motivation at a higher layer on motivation at the next lower layer of the model –

global motivation affects context motivation and context motivation affects situational motivation. The recursive relationship is also recognized although this is not considered to be an immediate relation. When a person, for example, experiences low levels of motivation in multiple sporting competitions (situational motivation), his or her motivation for sporting activities (contextual motivation) may be influenced over time.

Consistent with the Hierarchical Model we state that a person's contextual motivation affects his or her situational motivation. This means that if one's contextual motivation shows a high preference for receiving rewards for sporting activities, this person continues to have such a preference in a specific situation – even in situations in which rewards are absent. Thus, extrinsic motivations also exist in situations where no rewards are provided. It is therefore essential that extrinsic motivation is always measured irrespectively of the presence or absence of rewards. We argue that by not measuring extrinsic motivation only a partial explanation of behavior is achieved and therefore we include extrinsic motivation as a denominator of free choice behavior.

Rewards having moderating effects

Consistent with our reasoning that motivation is a rather stable orientation, we argue that contextual factors have moderating effects and do not directly influence one's motivation orientation. This means that when a person is strongly extrinsically motivated, his or her extrinsic motivation is not increased by the presence of a reward. This person will, however, adapt his/her behavior to influence the chance of receiving the reward.

Interaction effects of intrinsic and extrinsic motivations

We expect that a combination of intrinsic and extrinsic motivations result in a variety of sensitivities for rewards that can not be exclusively explained by direct effects. Interaction effects are explained by the (un)importance that the task giver communicates by (not) providing rewards. People with high intrinsic motivation will show different sensitivities for this signalling of unimportance, based on their level of extrinsic motivation. When they have low extrinsic motivation, people that are strongly driven by intrinsic motivation are expected to be very sensitive for feelings of autonomy and not susceptible to positive stimuli created by rewards. When people combine high intrinsic motivation and high extrinsic motivation, they are at the one hand receptive to the signals created by rewards because of their extrinsic motives, and at the same time are susceptible to the importance attached to the task since it affects their intrinsic motivation.

Persons combining low intrinsic and low extrinsic motivation are expected to be rather insensitive to being rewarded or not. On the other hand we expect that persons with low intrinsic and high extrinsic motivation are very sensitive to the absence of rewards. The absence of rewards will signal the unimportance of the task and will not only have a negative effect on people with high extrinsic motivation, that are seeking external stimuli and confirmation for their behavior, but also undermines the effects of intrinsic motivation on performance.

We explained earlier that CET/SDT scholars limit their conclusion to the premise that financial rewards undermine the behavior of people who are strongly driven by intrinsic motivation. Alternatively, GIT explaining both undermining and enhancing effects is applicable to people with high and low intrinsic motivation. Through the addition of interaction effects we will be able to explain the diversity of outcomes of the different field studies.

The inclusion of extrinsic motivation, the moderating effects of rewards and the interaction effects of intrinsic and extrinsic motivations result in the following adjustments to the existing motivation models of cognitive psychologists:

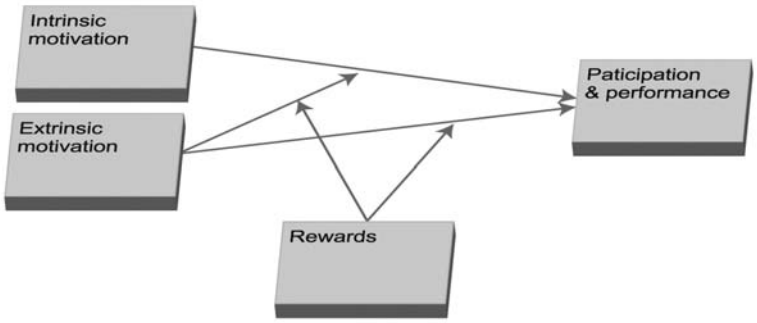

Figure 6 Adjusted theoretical model

3.2. Development of hypotheses

Our theoretical model consists of both the direct effects of motivation, moderated by rewards, and the interaction effects between different types of motivation. In the next sections we will develop hypotheses addressing the details of this theoretical model. All hypotheses focus on the effects of motivation on participation and performance. We use a single measure for participation, namely the decision to contribute, and multiple

performance measures: quantity of contributions, usefulness of contributions and the novelty of contributions.

We start with the effects of intrinsic motivation on participation and performance, followed by the effects of extrinsic motivation and finally describe the interaction effects of intrinsic and extrinsic motivations.

3.2.1. Effects of intrinsic motivation

The psychology literature assumes that intrinsic motivation is key for free choice behavior, primarily measured as the time spent on the activity. Scholars in this field usually collect their empirical evidence in laboratory studies in which the behavior of a rewarded group is compared to an unrewarded control group. Participants are usually stimulated by rewards or obliged to participate. As a consequence, in this literature, the role of motivation in the decision to start voluntary behavior is not studied. We assume that in real life settings intrinsic motivation is important for the decision to perform voluntary behavior. We hypothesize:

> ***Hypothesis 1.*** *Intrinsic motivation of an online volunteer has a positive effect on the decision to contribute to the online community.*

When a person decides to contribute, he still can choose to provide a lower or higher number of contributions. The psychology literature expects a positive effect of intrinsic motivation on the quantity of free choice activities (Deci et al, 1999; Eisenberger, 1999b). These expectations are partly confirmed by the literature on online and open source communities. Some studies found positive effects (Nov, 2007; Shah, 2006) while others did not find any effects (Wasko and Faraj, 2005; Roberts et al, 2006). We follow psychology researchers and assume that intrinsic motives have a positive effect on the number of contributions:

> ***Hypothesis 2.*** *Intrinsic motivation of a community member has a positive effect on the quantity of contributions.*

People who contribute to online communities aim their contribution at clients or users of the information. They may find it important that the contribution is indeed useful for others. We define ‘usefulness’ as the value of a contribution for other visitors of the site. In literature, only limited suggestions for the relationship between intrinsic motivation and usefulness are provided. Intrinsic motivation is not found to be a driver in the usefulness of

responses to newsgroups (Wasko and Faraj, 2005). We expect that intrinsically motivated people will of course aim their contributions at users of the site, but that they will mainly be guided by their own criteria in their activities. Therefore we expect no relation between intrinsic motivation and usefulness.

Our last performance measure in this study is novelty. Novelty can be described as originality by virtue or the quality of newness. It is not identical to creativity, which is defined by many authors as the combination of usefulness and novelty (Amabile, 1996; Litchfield, 2008). Amabile (1983) proposes that intrinsic motivation is mainly conducive to novelty, but she does not provide empirical evidence. There is a variety of practical examples in which persons respected for their novel creations, such as Albert Einstein and novelist John Irving, indicate that high intrinsic motivation is an important driver of their successes (Amabile, 1997; Amabile, 1998). Therefore, we argue that intrinsic motivations increase the novelty of contributions.

Hypothesis 3. *Intrinsic motivation of a community member has a positive effect on the novelty of contributions.*

3.2.2. Effects of extrinsic motivation

We argued that rewards and extrinsic motives are not identical concepts. Nevertheless, they are closely related. Based on the psychology literature, we expect that extrinsic motives have a positive effect on free choice behavior when rewards addressing these extrinsic motives, are provided (Kerr, 1975). For instance, when a person is motivated by recognition, he or she will demonstrate more free choice behavior if that behavior can lead to recognition; when a reputation system is present, for example. The positive effect of extrinsic motives in the presence of rewards will at least apply to the decision to contribute, since contributing is always required to be eligible for a reward. The effects on the other three performance outcomes, quantity, usefulness and novelty, will depend on the definition of the reward (Eisenberger and Rhoades, 2001). If rewards depend directly on the quantity of contributions, or if the chance to receive a reward is increased by submitting a higher quantity of contributions, then we expect a positive effect of extrinsic motives on quantity. If the reward is based on usefulness or novelty of the contributions, we expect a positive effect on that respective performance measure. We hypothesize:

Hypothesis 4a. *When rewards are provided, extrinsic motives related to these rewards have a positive effect on the decision to contribute.*

Hypothesis 4b. *When rewards are provided, extrinsic motives related to these rewards have a positive effect on quantity, usefulness and novelty, depending on the criteria defined to receive a reward.*

When rewards are absent, we expect a negative effect of extrinsic motives related to these rewards because the absence of the reward is a dissatifier. For example, when a community member has a high desire for receiving compensation and no financial rewards are offered, the person is expected to have a lower willingness to contribute and to show lower performance, since he or she will feel under-rewarded in his or her free choice behavior. We expect these effects for all our performance measures, the decision to contribute, and for the quantity, usefulness and novelty of contributions, since all of these will be negatively affected when rewards are absent.

Hypothesis 5. *When rewards are absent, extrinsic motives related to these rewards have a negative effect on the decision to contribute and on the quantity, usefulness and novelty of contributions.*

3.2.3. Interplay of intrinsic and extrinsic motivation

As discussed before, we expect that the effects of intrinsic and extrinsic motives interact, dependent on the presence or absence of rewards. In line with SDT, we expect that the absence of rewards will create feelings of autonomy and self-determination in people with low extrinsic motivation and, as a consequence, the intrinsic motivations of these people will have a higher effect on performance. As indicated above, people with low extrinsic motivation and high intrinsic motivation are enthusiastic for the task, and will react positively in the absence of rewards since for them this emphasizes that this task must be performed by people acting autonomously based on high intrinsic motivation. In line with GIT, we expect that the absence of rewards will signal unimportance of the tasks to people with high extrinsic motivation. People with high extrinsic motivation seek external stimuli and confirmation for their behavior. The signal that the task is unimportant will decrease the effects of intrinsic motivation of these people on performance (Eisenberger et al, 1999b). So we hypothesize:

Hypothesis 6. *When rewards are absent, extrinsic and intrinsic motivation interact in such a way that at low levels of extrinsic motivation the positive effects of intrinsic motivation on the decision to contribute, and on the quantity, usefulness and novelty of contributions increase, and at high levels of extrinsic motivation the positive effects of intrinsic motivation on the decision to contribute, and on the quantity, usefulness and novelty of contributions decrease.*

Hypothesis 6 covers the group of contributors with high intrinsic motivation. We expect that only high intrinsic motivated people are sensitive to the interaction with extrinsic motivation. Low intrinsic motivation people are expected to be less sensitive to feelings of autonomy and irrelevance caused by the absence of rewards and they are therefore much more indifferent to potential interaction effects of extrinsic motivation. In situations where rewards are present, we do not expect interaction effects. The reason for the lack of interactions in these situations is that we expect that the positive effect caused by the signalling of relevance of a task offsets negative effects due to the controlling aspects of a reward.

3.3. Conclusion

In this chapter we developed an alternative approach for effects of motivation and rewards on behavior. By inclusion of extrinsic motivations and the investigation of the combination of the absence and presence of rewards with motivation levels, we contribute to solving the dispute in the psychology literature.

In general we expect a positive direct effect of intrinsic motivations on participation and performance. The only exception is usefulness of contributions for which we expect no effect of intrinsic motivations. We expect that the direct effects of extrinsic motivations are dependent on the presence or absence of rewards. When rewards are provided, a positive effect on participation and behavior is expected. We expect direct negative effects of extrinsic motivations on participation and performance when no rewards are provided. Finally, interaction effects of intrinsic and extrinsic motivations are solely expected for the group of high intrinsic motivation people in the absence of rewards. The hypotheses are visualized in Figure 7.

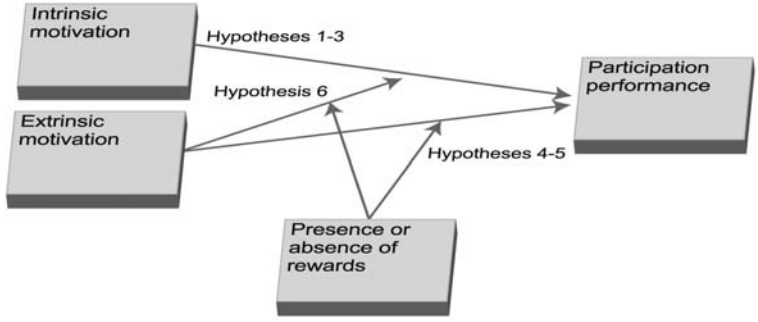

Figure 7 Theoretical model and hypotheses

In Table 3, the effects resulting from hypotheses 1 to 6 are depicted for the different motivation orientations and for rewarded and non-rewarded situations. Please note that the first row indicates the net effect of the direct and interaction effects.

Table 3 Net effects resulting from hypotheses 1 to 6

	High intrinsic and low extrinsic motivation	**High intrinsic and high extrinsic motivation**
Absence of rewards	***High Positive Effect*** – Positive direct effect intrinsic motivation (large), – Negative direct effect extrinsic motivation (small), – Enhancing interaction effect	***Negative Effect*** – Positive direct effect intrinsic motivation (large), – Negative direct effect extrinsic motivation (large), – Undermining interaction effect
Presence of rewards	***Positive Effect*** – Positive direct effect intrinsic motivation (large), – Positive direct effect extrinsic motivation (small), – No interaction effect	***High Positive Effect*** – Positive direct effect intrinsic motivation (large), – Positive direct effect extrinsic motivation (large), – No interaction effect
	Low intrinsic and low extrinsic motivation	Low intrinsic and high extrinsic motivation
Absence of rewards	***No Effect*** – Positive direct effect intrinsic motivation (small), – Negative direct effect extrinsic motivation (small), – No interaction effect	***Negative Effect*** – Positive direct effect intrinsic motivation (small), – Negative direct effect extrinsic motivation (large), – No interaction effect
Presence of rewards	***Low Positive Effect*** – Positive direct effect intrinsic motivation (small), – Positive direct effect extrinsic motivation (small), – No interaction effect	***Positive Effect*** – Positive direct effect intrinsic motivation (small), – Positive direct effect extrinsic motivation (large), – No interaction effect

Chapter 4. Methodology

4.1. Introduction

This thesis describes the study of three crowdsourcing initiatives: Tweakers.net, NU.nl and the Green Challenge innovation contest. The selection of these initiatives was based on three criteria. First, we sought to study large scale crowdsourcing initiatives. Tweakers.net and NU.nl are popular sites – both listed in the top 25 sites in the Netherlands[18] – and each site attracts over 1,000 contributors. The number of participants in the Green Challenge 2008 contest (235) was below 1,000, but compared to similar innovation contests which attracted less than 30 participants (e.g. Vodafone Mobile Start-up Challenge 2008) was still a success. Second, we wanted to study initiatives with different reward mechanisms. Tweakers.net does not provide any financial rewards, NU.nl pays small prizes for exceptional contributions, and finally the Green Challenge pays a substantial amount to the winner of the contest. All of these crowdsourcing initiatives provide reputation rewards. Third, the crowdsourcing organization had to be willing to share data related to the contributors with us so that we had objective data on participation and performance. Tweakers.net, NU.nl and Green Challenge were willing to share participation and performance data and even the original contributions of respondents when performance data was not available.

In the first study, Tweakers.net, recognition rewards were present and financial rewards were absent. Therefore, we were able to test all our hypotheses. The second study, NUfoto.nl serves as a replication of the first study and should confirm the results of the first study. It should be noted that in the NUfoto.nl study hypotheses 5 and 6 could not be tested since rewards were present in this study.

The objective of the third study, Green Challenge, is different. We acknowledge that the context of this study is significantly different since participants of the Green Challenge can win extreme financial rewards (€0.5 million). In this study we explore effects of extreme money rewards using the same analysis framework as in previous studies. Therefore, this study should be considered as an explorative study rather than a hypothesis testing study.

[18] www.alexa.com, download date November 2007

The three studies follow the same research design which consists of the measurement of motivation through a websurvey, the collection of objective participation and performance data and a statistical analysis. When the crowdsourcing organization did not have data on usefulness and novelty, an expert team assessed original contributions and provided a rating for these performance aspects. The research design is described in detail in the next three paragraphs. It should be noted that in our studies we collected data from multiple sources which is positive in avoiding a common method bias.

4.2. Measurement of motivation

4.2.1. Approaches to measure motivation

In an early stage of our research project we had interviews with executives of three crowdsourcing initiatives (SKOEPS, NU.nl and KijkMijTV) to check whether they had information on the motivation of contributors available. These interviews revealed that executives had not measured the motivation of people contributing to their website. They had their own opinion on which motives are relevant for providing contributions, but they never validated these opinions (Borst and Van den Ende, 2007).

For the measurement of motivation several approaches can be used (Mayer et al, 2007). A first approach consists of assessing a person's mental model; based, for example, on an examination of the thematic content of a person's story. The study of Füller et al (2007) is an example of this indirect measurement of motivation: researchers derive information on motivation of online participants by interpreting the online posts of these participants. The second approach consists of a self-judgment scale in which a person is directly asked about his or her motivation for a task. The third approach derives motivation from the tasks that people are working on. In this approach the measurement of motivation is based on the output a person delivers. An example is motivation measured as the time spent on a task. We decided to use the self-reported measure of motivation meaning that we asked online volunteers to assess their own motivations levels.

4.2.2. Motivation measurement tool

We used the Work Preference Inventory (WPI; Amabile et al, 1994) to measure the motives of respondents. The WPI is a tool designed to measure the degree to which adults perceive themselves to be intrinsically and extrinsically motivated toward what they do. The WPI tool is used in a number of studies, including recent ones (e.g. Pierro et al, 2008; Mueller et al, 2008). Although reported confirmatory factor analysis of WPI data showed somewhat

low model fit statistics (Amabile et al, 1994), this tool was still the best choice. Other motivation scales, such as Sport Motivation Scale (Pelletier et al, 1995) and a scale operationalizing the Self Determination Theory (Vallerand et al, 1997) were not applicable since they did not consider the motive 'desire for compensation' or only interpreted motivation in terms of satisfying the need for self determination.

The WPI tool consists of 29 motivation items. For 4 items reversed phrasing is used. We listed items randomly in our questionnaire. Each item had to be scored on a 6 point Likert scale.

4.2.3. Other issues regarding questionnaire development

Besides motivation items, we also included in the questionnaire questions measuring control variables. The questionnaire for the Green Challenge study did not include the demographic questions since demographic data was already provided at the submission of the high level business plan.

For the Tweakers.net and NUfoto.nl studies we translated the questionnaire in Dutch since this is the official language in these communities. In order to guarantee consistency with the original questionnaire, a person, that was unfamiliar with the original questionnaire, translated the Dutch items back into English. Comparison of the re-translated questionnaire and the original questionnaire demonstrated that the items had not changed due to translation. For the Green Challenge study no translation was required, the official language of this website was English. All participants, including Dutch participants, had to provide an English submission.

All items of the questionnaire were obligatory, this means that respondents could not continue if they did not fill in all questions. Although obligatory questions require more time from respondents, we felt that the time needed to fill in the complete survey was acceptable. Pre-testing of the survey showed that completing the survey took on average 10 to 15 minutes.

The survey questions were also pre-tested by persons who organised the crowdsourcing activities to reveal problems such as questions that contain unwarranted suppositions, awkward wordings and missing response categories (Presser et al, 2004). The pre-tests resulted in minor adjustments to the questionnaire.

4.2.4. Websurvey procedure

In order to improve the trustworthiness of the websurvey and to stimulate response, an invitational mailing for the websurvey was sent on behalf of the contact person of the crowdsourcing organization.
The invitational mailing was sent to all participants of the Green Challenge 2008 and all registered visitors of NUfoto.nl. For the Tweakers.net study we did not invite all registered visitors of the newsfora (about 19,000 visitors) but a random sample of 3,000 persons. A stratified sampling was not possible since no demographic characteristics were known of individual visitors.

One week after mailing the invitation mail, a reminder mail was sent to the non-respondents. One week later, the survey was closed. Each websurvey was conducted in a two-week time frame.

Respondents did not receive a reward for filling in the websurvey in the Tweakers.net and NU.nl studies. We followed a different procedure in the Green Challenge study and promised the non-respondents in a second reminder mail a reward upon completion of the survey. The reason for this alternative procedure is that we expected the Green Challenge participants to be more extrinsic motivated since a substantial financial reward was offered in this contest. In Chapter 7 we discuss the effects of providing a reward for filling in the websurvey.

4.3. Collection of participation and performance data

4.3.1. Data sources

Data on participation and performance of respondents were derived from the systems of the crowdsourcing organization. NU.nl and the Green Challenge did not have ratings of usefulness and novelty per individual respondent available. Instead we received the contributions that individual respondents provided and arranged an expert team to assess usefulness and novelty of these contributions. In Table 4, data sources per study and per participation and performance measure are shown.

For the Green Challenge study we were not able to track persons interested and willing to participate, but who decided not to submit their high level business plan. Therefore we could not include non-contributors in our websurvey and subsequent analysis. The quantity

measure did not appear relevant for the Green Challenge study because only a few people submitted more than one business plan.

Table 4 Data source per participation and performance measure

Data source per variable	Tweakers.net	NU.nl	Green Challenge 2008
Decision to contribute	Data on registered, non-contributing and contributing visitors retrieved from archival system	Data on registered non-contributors and contributors retrieved from user generated platform	Not applicable
Quantity	Number of reaction on newsfora retrieved from archival system	Number of news photos uploaded retrieved from user generated platform	Not applicable
Usefulness	Peer ratings retrieved from archival system	Rating expert panel	Rating expert panel
Novelty	Peer ratings retrieved from archival system	Rating expert panel	Rating expert panel

The way performance is measured varies per study. In Chapters 5 to 7 we describe for each study the measurement methods.

4.3.2. Expert panels

In accordance with guidelines provided by Amabile (1982) we used expert panels of members that have relevant knowledge and experience of the task that had to be assessed. This means that the expert panel for the NUfoto.nl study consisted of (semi) professional photographers and the members of the panel for the Green Challenge study has experience with assessment of business plans, innovative and sustainable products and services, and new technologies. Both panels consisted of 3 members, herewith fulfilling the requirements of the minimum number of members (Piller et al, 2006; Amabile et al, 1996). Since the accuracy of judges significantly improved in the presence of rewards (Sniezek et al, 2004), the members of the expert panels received a reward for their work.

Members of the expert panel were individually instructed on how to assess usefulness and novelty using scales that were specific to the assessment. They also received an explanation in writing which could be used during the actual assessment. Experts provided their ratings individually within a two week period.

Interjudge reliability was analyzed on each performance measure. Intraclass correlation (ICC) values above 0.7 indicate a high degree of consensus (Piller et al, 2006).

4.4. Variables

4.4.1. Independent variables: motivations

The Work Preference Inventory (WPI) distinguishes two intrinsic motives: pleasure and challenge, and two extrinsic motives: outward and the desire to receive compensation (Amabile et al, 1994). Intrinsic pleasure is applicable when activities are pursued for the sake of fun or enjoyment and includes elements of self-determination and intrinsic task interest. The motive of challenge involves the desire to learn or improve skills, intellectual interest or curiosity. Outward is described as "the orientation toward the recognition and the dictates of others" which is identical to our definition of motive 'desire to receive recognition'. The WPI tool consists of 7 items regarding feelings of pleasure, 7 on feelings of challenge, 5 on the desire to receive compensation and 10 on the desire to receive recognition.

The Green Challenge study required an extension of intrinsic motivation factors. The organization of the Green Challenge aims to receive business plans for innovations that reduce green house gas emission and therefore the motive of social responsibility (Nov, 2007; Franke and Shah, 2003) may be very relevant for participants of this innovation contest. This intrinsic motive and the development of items measuring this motive are described in Chapter 8.

We translated the motivation items into the context in which community members provide their contribution. The reason for this is that we do not want to measure a person's generic motivation orientation, but his or her contextual motivation (Vallerand, 1997; Mayer et al, 2007). Although a person's generic motivation orientation and his or her contextual motivation are related, contextual motivation describes more precise why a person engages in the specified activity.

4.4.2. Control variables

We choose control variables that refer to demographic factors since field studies of economists (e.g. Day et al, 1996) showed that these factors are relevant for voluntary behavior in offline contexts. We included questions on gender, age, highest education level, education and working experience relevant for the crowdsourcing activity.

4.4.3. Dependent variables: participation and performance measures

Performance measurement is defined as the ability to measure progress towards a goal (Genskow and Wood, 2010). The general reason behind measuring performance is the desire to improve performance (Behn, 2003). Therefore performance measurement is considered to be an important management tool. However, the selection of performance measures is not a simple endeavour (Radin, 2006). Some desired outputs are difficult or impossible to measure and other outputs that can be measured very easy appear not to be relevant.

The crowdsourcing firm desires to tap into the crowd with its open call for engaging in a task. So the success of crowdsourcing is firstly dependent on participation of online volunteers. Participation can be measured through the decision to contribute. People that made a positive decision became contributors, while non-contributors made a negative decision.

Once the online volunteers become contributors, they can show different performance. According to Schenk and Guitard (2009) the main performance indicators of crowdsourcing are quantity, usefulness and uniqueness of output. It is a well known phenomenon that the majority of contributors are only active for a very short term in which they provide a few contributions. Only very few contributors provide regular and large numbers of contributions (Lerner and Tirole, 2002). Therefore the first performance measure is ‘quantity’ or number of contributions per volunteer. Next the output that online volunteers provide, can match differently with the requirements of the crowdsourcing firm. This is the performance measure ‘usefulness’ or the extent that a contribution satisfies the requirements of the crowdsourcing firm. Finally, the newness or novelty of a contribution can be an important objective of a crowdsourcing company, for example when online volunteers are involved in idea generation or user-innovation activities.

4.5. Statistical methods

4.5.1. Confirmatory factor analysis

In this research we measure motivation, a so called 'latent variable' that can not be directly measured but only indirectly via the measurement of different aspects of motivation. For example learning new skills and the enjoyment of solving complex issues are aspects underlying the motive challenge. When the underlying aspects show high correlations, it is suggested that they indeed measure the same latent variable. Latent variables are also known as factors. The technique for clustering correlated aspects in a reduced number of factors is called factor analysis (Field, 2005).

Two types of factor analysis can be distinguished: Exploratory Factor Analysis and Confirmatory Factor Analysis. Exploratory Factor Analysis (EFA) explores the possible underlying factor structure of a set of observed variables without imposing a preconceived structure on the outcome (Child, 1990). The factor structure is determined on basis of correlation between the observed variables. Confirmatory Factor Analysis (CFA) differs from EFA in the sense that it allows testing of a factor structure hypothesized in advance. It is recommended to select CFA when an a priori theory on the factor structure is available (Hurley et al, 1997; Williams, 1995). Since we use in our research an existing tool for the measurement of motivation, we decided to perform Confirmatory instead of Exploratory Factor analysis.

Structural Equation Modelling software is typically used for performing CFA. LISREL and AMOS are examples of popular Structural Equation Modelling software programs. We used LISREL 8.80 software to verify our predefined factor model. Verification of a CFA model consists of an assessment of the overall model and an assessment of validity and reliability of the indicators provided by the model (e.g. factor loadings and measurement errors).

Overall model fit

We followed Diamontopoulos and Siguas (2000) and based our assessment of the overall model fit on the Root Mean Square Error of Approximation (RMSEA), Standardized Root Mean of square Residual (SRMR) and Comparative Fit Index (CFI).

Although the chi-square is a traditional measure of overall model fit and frequently used in different types of statistical analyses, we did not use it in our CFA. The chi-square statistic has to be treated with caution since it is very sensitive to the sample size and model

complexity (Newton, 2005). Practice show that it is difficult to have non-significant chi-squares for samples larger than 200 cases. In addition models with more variables also tend to have larger chi-squares. Since our research includes large samples we prefer the RSMEA as an indicator of the discrepancy of the model and the observed data per degree of freedom. This statistic is not sensitive to sample size. RMSEA is generally regarded as one of the most informative fit indices. A RMSEA value lower than 0.10 is considered to be acceptable (Diamontopoulos and Siguas, 2000; Hu and Bentler, 1999).

The second fit statistic that we used is SRMR which assesses the values of residuals. If a model fits well the residuals should be small relative to the magnitude of observed values for elements. A summary measure of fitted residuals is the root mean square residual (RMR). A problem with interpreting RMR is that the size varies with the unit of measurement which can vary per variable. This problem can be avoided through the use of standardized values. A summary measure of standardized residuals is SRMR, it's value should be lower than 0.08 (Diamontopoulos and Siguas, 2000; Hu and Bentler, 1999).

The last fit statistic is CFI, a relative fit statistic which shows how much better the model fits compared to a baseline model. The literature recommends that CFI ought to be relied on for fit assessment (Jöreskog and Sörbom, 1996). A CFI value of more than 0.10 is considered to be acceptable (Diamontopoulos and Siguas, 2000; Hu and Bentler, 1999).

It well may be that the factor structure derived from theory is, in practice, less complex. We for example distinguish between subcategories of intrinsic and extrinsic motivation based on theory. In practice these subcategories may be very similar thus it would be better to abandon these subcategories and only use intrinsic and extrinsic motivation. To check for the optimal factor structure, we run alternative factor models with smaller numbers of factors. We compared the fit of these models on the basis of the Expected Cross Validation Index (ECVI) and Consistent Akaike's Information Criterion (CAIC). Models with smaller values for ECVI and CAIC can be selected as the better model (Diamontopoulos and Siguas, 2000).

Validity and reliability of model indicators

The factor model provides values for factor loading and measurement error. The factor loading indicates the level of correlation between the factor and the underlying aspect or variable. The underlying variable is only a valid indicator of the factor, when the factor loading is substantial or higher than 0.4 (Field, 2005). The measurement error shows how precisely the factor loading is estimated; the smaller the measurement error, the better the estimation.

In addition to assessing the reliability of individual factors, the values for composite reliability and average variance extracted also have to be checked. Composite reliability values use information of both factor loadings and measurement errors. When values are greater than 0.6 it can be concluded that variables provide a reliable measurement of the factor (Diamontopoulos and Siguas, 2000). A complementary measure is the average variance extracted. This measure shows the amount of variance that is captured by the factor in relation to the variance due to the measurement error. When the average variance extracted is above 0.5, it can be concluded that a substantially higher amount of variance in the indicators is captured by the construct as compared to the variance in measurement error (Diamontopoulos and Siguas, 2000).

4.5.2. Regression analyses

In our studies, the dependent variables appear to be of different types and had different distributions. So we needed multiple statistical models for hypotheses testing. For normally distributed interval variables we used linear regression. For nominal variables we used logistic regression. For count variables we used negative binomial regression.

Negative binomial regression

In our research we collected count data or non-negative integers. Examples of count data are simple counts of occurrences, in our case number of reactions provided in newsfora or number of news photos uploaded. The standard regression method to be used for count data is Poisson regression. However, Poisson regression requires equality of mean and variance. Since our count data is overdispersed (i.e. the variance is greater than the mean) we used negative binomial regression (Gardner et al, 1995; Cameron and Trevedi, 1998; Hilbe, 2007). The variance function of negative binomial distribution data is $\mu + \alpha\mu^2$ in which μ is the mean and α is the so called overdispersion parameter (Hilbe, 2007). Higher values of α indicate higher overdispersion or more variance. If there is no overdispersion in the data the dispersion parameter has a value of 1.0.

Overdispersion can also be proven in the likelihood-ratio chi-square testing that the dispersion parameter α is equal to zero. A large test statistic would suggest that the response variable is over-dispersed and is not sufficiently described by the simpler Poisson distribution.

Hurdle model

In our data, in addition to overdispersion, we observed excessive zero counts. Hurdle count models are one of the foremost methods used to deal with count data having excessive zero counts (Hilbe, 2007). The essential idea of a hurdle model is to split the model in two parts: first a binary process generating positive counts (1) versus zero counts (0), second a process generating only positive counts. The binary process is modelled using a binary model (complementary loglog or logit model); the positive count process is modelled using a zero-truncated model (Hilbe, 2007). StataSE 10 was used to estimate the zero-truncated regression models.

Assessment of model fit

Negative binomial regression can be viewed as a nonlinear regression model estimated by maximum likelihood. Therefore it is a member of the family of generalized linear models (GLM). In general the deviance, log-likelihood function, the Akaike Information Criterion (AIC) and the Baysean Information Criterion (BIC) are used to assess the fit of a GLM model. Following Hilbe we used a log-likelihood ratio test and the AIC and BIC statistics. The preferred model has the highest log-likelihood as well as the lowest AIC or BIC statistics (Hilbe, 2007).

Interpretation of coefficients

To assess the relationship between the response and predictors expontentiated coefficients must be used. An exponentiated coefficient, the so-called incidence rate ratio (IRR), indicates the change in count data when one unit increase or decrease in the predictor occurs, given that the other variables are held constant. An IRR smaller than one, indicates a negative effect of this independent variable. An IRR larger than one, indicates a positive effect[19].

4.6. Conclusion

In this chapter we explained how we selected cases in which the reward systems varied. Specifically, we sought to have variation in the financial reward systems. Tweakers.net does not provide financial rewards while NUfoto.nl offers a small reward and the Green Challenge a substantial monetary prize. Although this selection provides potentially

[19] Incidence Rate Ratio Interpretation, UCLA Academic Technology Services, http://www.ats.ucla.edu/stat/Stata/output/stata_nbreg_output.htm, downloaded 22 October 2009

interesting insights for cross case analysis, e.g. what is the difference between the absence and presence of financial rewards, the selection also resulted in cases where both financial and reputation rewards were present. As a consequence the full set of hypotheses can not be tested in all studies.

We further selected the Work Preference Inventory, a motivation scale measuring self-reported motivation which distinguishes two types of intrinsic motivations (i.e. pleasure and challenge) and two extrinsic motivations (i.e. desire for compensation and desire for recognition).

We explained the websurvey procedure and the data gathered via the crowdsouring organization. When no data on the performance measures were available, we introduced expert panels as an alternative for gathering performance data. Experts based their performance assessment on the original contributions of respondents as provided by the crowdsourcing organization.

Finally, we explained that in addition to common statistical analysis methods, such as linear and logistic regression, less well known methods also needed to be used. We used, for example, confirmatory factor analysis and structural equation modelling in determining the factor structure and negative binomial regression to deal with overdispersed count data. We briefly described these methods and their critical values for accepting results.

Chapter 5. Case 1: Tweakers.net

5.1. Introduction to Tweakers.net

The first empirical study, in which we tested our hypotheses, was in the Dutch IT community Tweakers.net. Tweakers.net provides news and information on hardware, software, games and the internet targeted at IT (Information Technology) hobbyists and professionals. Tweakers.net was founded in 1998 under the name "World of Tweaking" in which tweaking stands for the optimization of computers. Tweakers.net grew from a small website run by hobbyists into a big and professional site comparable to the English-language site Slashdot. In March 2006, Tweakers.net was taken over by the Dutch media company VNU[20]. More than 25 persons are employed by Tweakers.net[21].

Tweakers.net targets people interested in electronics and technology. Visitors of the site are primarily well educated males between the ages of 20 and 49. Per day, approximately 170,000 persons visit the Tweakers.net site. Tweakers.net reached 3.5 million unique visitors per month and its visitors generate about 65 million page views. Over 300,000 persons are registered as members – so called Tweakers – of the Tweakers.net community. Since the site generates considerable traffic; it comes in at 31 among the top 100 Dutch websites in terms of traffic statistics[22].

On the front page of the website, actual news on IT subjects are published[23]. The front page content is provided by the Tweakers.net professional editorial staff. The editorial staff adds news and reviews 18 hours per day, seven days per week. Additionally, Tweakers.net provides product and pricing information on hardware and software products and services; termed Pricewatch[24]. Pricewatch gives an overview of the lowest prices per product and also a review of the shops offering these products. An important part of the site is its forum: Gathering of Tweakers (GoT)[25] where IT subjects are discussed at a highly technical level. Tweakers can initiate their own discussions and can provide responses to one another's

[20] http://nl.wikipedia.org/wiki/Tweakers.net
[21] http://tweakers.net/reviews/331/tweakers-punt-net-faq.html
[22] www.Alexa.com, downloaded June 2010
[23] http://tweakers.net/archieven/cat/1/nieuws
[24] http://tweakers.net/pricewatch/
[25] http://gathering.tweakers.net/

discussions. A subset of the community members also contribute as moderators. This means that these volunteers keep discussions on track. Finally, Tweakers.net has a bulletin board with IT vacancies and an online market place for IT products.

In 2009, Dutch internet users selected Tweakers.net as the "Website of the year".

Our research focused on participation in the Tweakers.net news forum. The editorial staff of Tweakers.net publishes news items on this part of the website. Registered visitors can respond to an item by posting a text message. The contributions investigated in this study consist of the responses to items published on the news forum of Tweakers.net.

5.1.1. Financial and reputation rewards

Members of the Tweakers.net community, the so called Tweakers, do not receive monetary benefits for their contribution to the news forum, but receive reputation rewards when becoming more active. Tweakers.net has a sophisticated reputation system that weights the number of generated page views and posts and received peer ratings for contributions. The number of page views a person generates is the basis for his or her 'Tweakotine level' or his/her addiction to Tweakers.net. A Tweaker's Karma indicates the added value that this person holds for the Tweakers community based on a peer rating system. The lists of top contributors in terms of quantity (Tweakotine, the combination of number of page views and posts) and added-value (Karma) are published on the website.

In the peer rating system, the ratings vary from -2 for unwanted reactions to +2 for very unique and valuable reactions. A +2 rating is used for unique content that is not known by the general audience of Tweakers.net. A +1 rating is used for useful, but not unique content. A zero rating stands for a neutral rating: the content is not really useful, but on the other hand does not harm the discussion. A -1 rating is used for responses which are unwanted, since they do not have any added value and cause irritation with other Tweakers. Finally a -2 rating is used for contributions that are incompatible with the law or with the Tweakers.net's policy.
The peer rating system is semi-democratic, meaning that not only staff members express their appreciation for a contribution, but also visitors to the site. Visitors have to register and qualify before they can participate in the peer rating system. Rating is a relative easy task: when logged in, a moderator can provide a rating with a single mouse-click.

Hypotheses testing
The hypothesized effects of extrinsic motives are conditional on the presence or absence of rewards. Tweakers.net has an advanced peer rating system that stimulates participation and

good performance. For example, a person's Karma level indicates the usefulness of this person's contributions and his or her Tweakotine level increases when the number of posts increases. Novel contributions are also recognized since the +2 ratings result in higher Karma levels than other ratings. Therefore the hypotheses on the effects of motivation in the presence of rewards (Hypotheses 4a and 4b) can be tested in this study.

In the Tweakers.net context financial rewards are absent. Therefore also the hypotheses on the effects of extrinsic motivations in the absence of rewards (Hypotheses 5 and 6) can be tested in this study.

5.2. Data collection Tweakers.net

We collected our independent and dependent variable data from two different sources: a web survey among registered Tweakers.net members and archival data gathered at Tweakers.net. The web survey measured the intrinsic and extrinsic motivation of individuals and the control variables. Archival data gathered at Tweakers.net provided data on our dependent variables: decision to contribute, quantity, usefulness and novelty.

An invitation for filling in the survey was sent to a random selection of 3,000 (1,500 contributors and 1,500 non-contributors) of the 19,000 registered members that had accessed the news in the one month preceding the survey. After one week a reminder was sent to non-respondents.

832 Contributors (55%) started the web survey and 691 of them (46%) completed the survey. 631 Non-contributors (42%) started the web survey and 415 (28%) of them completed it. We eliminated the data of 11 respondents who provided the same answers to at least 80% of the questions. We felt that these respondents were not seriously filling in the questionnaire, specifically when they gave the same answers to questions with reversed scaling. As a result, the data of 1,095 respondents was used in the subsequent analyses.

Despite the highly satisfactory response rate, there is a possibility of self-selection, since individuals being highly intrinsically motivated may be more likely to respond. Such self-selection could result in a disproportionately high rate of highly intrinsically motivated persons in the sample. While we had no information about non-respondents, we checked whether the responses of late respondents were similar to those of early respondents (Armstrong and Overton, 1977). The independent samples T-test of respondents before the

reminder and after the reminder shows no significant differences in mean scores for the four motives. The significance levels of the two-tailed t-test were all well above 0.05.

Data on our dependent variables (decision to contribute, quantity, usefulness and novelty) were derived from the systems of Tweakers.net. We chose to use the data from multiple months to increase the reliability of our analyses. We collected data from one month preceding the web survey (June 2008) and 4 months after the web survey (November 2008 – February 2009). Analysis showed that participation and performance of respondents were pretty consistent over time. For example the cumulative number of reactions per month provided by all respondents fluctuated by less than 4%.

5.3. Measurement of variables

In the Tweakers.net study, the dependent variables were the participation and performance measures decision to contribute, quantity, usefulness and novelty. The independent variables were the motives of respondents and a selection of control variables.

5.3.1. Decision to contribute

We distinguished between non-contributors and contributors on the basis of the number of contributions. Non-contributors did access the news fora but did not provide any reactions to the news items in the five months considered in this study. Contributors provided one or more reactions during this period. The number of reactions per respondent was derived from the website archive.

5.3.2. Quantity of contributions

We used the number of contributions as a measure of quantity (Lerner et al, 2006; Roberts et al, 2006). The source was the data archive of Tweakers.net. This measure is more objective that measures such as self-reported time spent on the activity (e.g. Nov, 2007; Lakhani and Wolf, 2005) or expected future participation (Füller, 2006).

5.3.3. Usefulness of contributions

The usefulness of the reactions to news items was assessed by the staff and visitors of the news forum in the Tweakers.net peer rating system. In this system, ratings vary from -2 to +2. To compute our measure of usefulness we took the average score for each reaction which we subsequently averaged per respondent.

5.3.4. Novelty of contributions

For the last performance measure, we distinguish between novel contributors and non-novel contributors by clustering all contributors with +2 ratings and those without +2 ratings. A contributor with one or more +2 ratings is a novel contributor, while a contributor without +2 ratings is a non-novel contributor.

5.3.5. Motives

As indicated in the methodology chapter, we used the Work Preference Inventory (Amabile et al, 1994) for the measurement of motivation in the websurvey. The original statements were adjusted in such way that they refer to the motivation associated with providing reactions to IT news items. For example the original statement "I am strongly motivated by the money that I can earn" was adjusted to "I am strongly motivated by the money that I can earn by publishing my knowledge on IT items". Subsequently, these statements were translated into Dutch. In order to guarantee consistency with the original questionnaire, the Dutch statements were translated back into English by a person that did not know the original questionnaire. A comparison of the re-translated questionnaire and the original questionnaire demonstrated that the items had not changed due to translation.

Each item was scored on a 6 point Likert scale. The complete survey was pre-tested on 20 persons and small improvements in language were made on the basis of the feedback from the testers. For the complete survey see Annex B.

5.3.6. Control variables

Since some field studies of economists (e.g. Day et al, 1996) conclude that demographic factors drive free choice behavior, we included gender, age, highest education level, education and working experience as relevant to providing reactions in the news forum as control variables. Relevant education and working experience were self-reported measures; we asked respondents whether they had followed IT education or worked in the IT sector.

5.3.7. Validity

Prior to testing the hypotheses, we conducted a confirmatory factor analysis (CFA) to examine the distinctiveness of the measures employed in this study. The initial estimated confirmatory factor model showed model fit statistics below acceptable levels (χ^2=1703.80 [179, n=1095]; p<0.01; RMSEA=0.09; CFI=0.88; SRMR=0.07). Subsequently we executed a specification search to arrive at the model that correctly represents the network of relations among manifest and latent variables (Diamantopoulos and Siguaw, 2000). The

specification search resulted in two types of modifications. Firstly, we allowed a few correlations between measurement errors of manifest items for a latent variable. These modifications are justified because the content of these items were related to each other. For example, we allowed correlations between the 3 compensation items focused on monetary benefits, while other items of the same construct were phrased in terms of general benefits. Secondly, we simplified the model by deleting unnecessary items. We deleted two items that caused cross loadings. The adjusted CFA model showed a sufficient fit (^{2}=624.25 [94, n=1095]; p<0.01; RMSEA=0.07; CFI=0.94; SRMR=0.05).

For completeness, we compared this higher-order four-factor model structure to three- and two-factor structures. In the three-factor models the two intrinsic or the two extrinsic motives are taken together in one factor, while in the two-factor model intrinsic and extrinsic motives serve as the two remaining factors. Runs of the three- and two-factor models showed that the Expected Cross Validation Index (ECVI) and Consistent Akaike's Information Criterion (CAIC) values increased as compared to the higher order, four factor model. This provided support for a four-factor model (Diamontopoulos and Siguas, 2000).

The composite reliability of each factor of the final model is greater than 0.60, the items provide a reliable measurement of each factor (Diamontopoulos and Siguas, 2000). The values of average variance extracted are larger than 0.50. So a substantially higher amount of variance in the items is captured by the factor compared to that accounted for by the measurement error (Diamontopoulos and Siguas, 2000).

5.4. Analysis methods

Since the dependent variables were of different types, having different distributions, multiple statistical models were required for hypothesis testing. For usefulness and novelty, we used linear regression and logistic regression, respectively. For the dependent variable quantity, a count variable, negative binomial regression was used because the data was overdispersed (Cameron and Trevedi, 1998; Hilbe, 2007). A likelihood-ratio test of overdispersion indicated that negative binominal regression was an appropriate choice. A special negative binomial regression model, a hurdle model, was used to deal with the excessive zero counts (Hilbe, 2007). As explained in the methodology chapter the idea of a hurdle model is to split the model in two parts: first a binary process generating positive counts (1) versus zero counts (0), second a process that generates only positive counts. In our analysis the binary process is modelled using a logit model and the positive count process is modelled using a zero-truncated model (Hilbe, 2007).

In all regression analyses, we followed a stepwise approach. In the first step, the five control variables were included. In the second step, we added the motivation variables and in the third step we added the interaction terms.

5.5. Results

Table 5 lists the means, standard deviations and correlations for the variables.

Table 5 Descriptive statistics and correlations – Tweakers.net

Variable	N	Mean	s.d.	1	2	3[a]	4	5	6[a]	7[a]	8[a]	9	10	11	12
1. Quantity	1095	19.56	53.18												
2. Usefulness	823	0.17	0.69	0.76*											
3. Novelty[a]	823			0.39**	0.24**										
4. Gender[a]	1095			-0.07*	0.04	0.02									
5. Age	1092	28.52	8.90	-0.04	-0.04	-0.09*	0.04								
6. Education[a]	1095			-0.04	0.12**	-0.03	-0.05	0.26**							
7. Relevant education[a]	1095			-0.07*	-0.07*	0.02	0.02	-0.03	-0.23**						
8. Relevant working experience[a]	1095			-0.06	-0.02	-0.01	0.04	-0.19**	-0.13**	0.51**					
9. Pleasure	1095	2.39	0.66	0.17**	0.04	0.15**	-0.02	-0.22**	-0.09**	-0.06	-0.05				
10. Challenge	1095	2.92	0.73	0.18**	0.02	0.13**	-0.04	-0.18**	-0.09**	-0.05	-0.07*	0.52**			
11. Compensation	1095	2.04	0.68	0.01	-0.12**	-0.01	0.03	-0.23**	-0.10**	-0.32**	-0.32**	0.22**	0.30**		
12. Recognition	1095	2.07	0.44	0.09**	0.12**	0.12**	-0.03	0.25**	-0.09**	-0.07*	-0.05	0.42**	0.42**	0.27**	

[a] For categorical data Spearman instead of Pearson correlations are shown

3. Usefulness dummy coded: 0 = non-innovative contributor, 1 = innovative contributor
4. Gender dummy coded: 1 = male, 2 = female
6. Education dummy coded: 1 = secondary general education, 2 = higher secondary general education, 3 = secondary vocational education, 4 = higher or academic education
7. Relevant education dummy coded: 1 = no relevant education, 2 = relevant education
8. Relevant working experience dummy coded: 1 = no relevant working experience, 2 = relevant working experience

* $p<0.05$

** $p<0.01$

Two-tailed t-tests

The intrinsic and extrinsic motives were all highly correlated ($r>0.45$, $p<0.01$). It is notable that all correlations are positive. The correlation matrix shows that the correlations between the intrinsic motives pleasure and challenge and the extrinsic motive desire for recognition ($r=0.55$ resp. $r=0.56$, $p<0.01$) are somewhat higher than the correlations between the intrinsic motives pleasure and challenge and the extrinsic motive desire for compensation ($r=0.52$ resp. $r=0.45$, $p<0.01$).

The unstandardized means and standard deviations for the intrinsic motives of pleasure and challenge and the extrinsic motives desire for compensation and desire for recognition are listed in Table 5. Standardized variables were used in all regression analyses to overcome multicollinearity (Aiken and West, 1991). Through standardization of the motives the maximum variance inflation factors (VIFs) obtained in any of the models did not exceed 1.5 and thus they were substantially below the cut off value of 10 for regression models (Field, 2005).

We report the results of the negative binomial hurdle analysis in Table 6. In Table 7 the results of the linear and logistic regression are presented. With the exception of the logistic regression model, testing the relations between independent variables and novelty, the full model – including control, first order and higher order variables – showed the best model fit in all regression models. In the logistic regression model on novelty, the model including the control and first order variables was the optimal model.

Table 6 Results hurdle model – Tweakers.net

	Logistic regression *Decision to contribute*			**Zero truncated negative binomial regression *Quantity***		
	Model 1	*Model 2*	*Model 3*	*Model 1*	*Model 2*	*Model 3*
Constant	2.96** *(0.45)*	2.36** *(0.51)*	2.37** *(0.51)*	3.55** *(0.47)*	3.59** *(0.47)*	3.81** *(0.31)*
Age	-0.05** *(0.01)*	-0.04** *(0.01)*	-0.04** *(0.01)*	0.00 *(0.01)*	0.00 *(0.01)*	0.00 *(0.01)*
Education	0.06 *(0.08)*	0.06 *(0.08)*	0.11 *(0.08)*	-0.11 *(0.08)*	-0.09 *(0.07)*	-0.12† *(0.07)*
Relevant education	-0.24 *(0.17)*	-0.23 *(0.18)*	-0.22 *(0.18)*	-0.16 *(0.17)*	-0.23 *(0.16)*	-0.27† *(0.15)*
Relevant experience	-0.21 *(0.18)*	-0.11 *(0.19)*	-0.13 *(0.19)*	-0.43* *(0.18)*	-0.37* *(0.17)*	-0.33* *(0.16)*
Pleasure		0.31** *(0.09)*	0.30** *(0.09)*		0.28** (0.08)	0.26** *(0.07)*
Challenge		0.32** *(0.09)*	0.34** *(0.09)*		0.41** *(0.08)*	0.43** *(0.08)*
Desire for compensation		-0.07 *(0.09)*	-0.09 *(0.09)*		-0.21** *(0.08)*	-0.19** *(0.07)*
Desire for recognition		0.12 *(0.08)*	0.14† *(0.08)*		-0.03 *(0.07)*	-0.06 *(0.07)*
*Pleasure * Desire for compensation*			-0.19(*) *(0.09)*			0.19(**) *(0.07)*
*Challenge * Desire for compensation*			0.19* *(0.09)*			-0.20** *(0.07)*
Log-likelihood	-590.29	-557.92	-554.71	-3231.34	-3198.73	-3193.82
Log-likelihood ratio χ^2	45.36**	110.10**	116.50**	11.31*	76.53**	86.34**
ΔLog-likelihood ratio χ^2	45.36**	64.74**	6.40*	11.31*	65.22**	9.81**
Δdf[a]	4	4	2	4	4	2
AIC				6474.68	6417.46	6414.13
BIC				6502.94	6464.56	6460.06
Dispersion parameter α				7.5	5.0	4.7

[a] From the baseline model.

† p<0.10

* p<0.05

** p<0.01

Table 7 Results linear and logistic regression – Tweakers.net

	Linear regression *Usefulness*			**Logistic regression *Novelty***		
	Model 1	*Model 2*	*Model 3B*	*Model 1*	*Model 2*	*Model 3*
Constant	0.14 (0.22)	0.35 (0.24)	0.36 (0.23)	-0.35 (1.34)	-0.67 (0.66)	-0.67 (0.66)
Age	-0.01 (0.00)	-0.01 (0.00)	-0.01 (0.01)	-0.03* (0.01)	-0.02† (0.01)	-0.02† (0.01)
Education	0.11** (0.04)	0.10** (0.04)	0.10** (0.04)	0.06 (0.10)	-0.04 (0.10)	-0.04 (0.10)
Relevant education	-0.09 (0.08)	-0.15† (0.08)	-0.15† (0.09)	0.15 (0.22)	0.11 (0.23)	0.11 (0.23)
Relevant experience	0.04 (0.08)	-0.02 (0.08)	-0.01 (0.08)	-0.24 (0.23)	-0.31 (0.24)	-0.29 (0.24)
Pleasure		-0.03 (0.04)	-0.04 (0.04)		0.30* (0.12)	0.29* (0.12)
Challenge		0.02 (0.04)	0.02 (0.04)		0.30* (0.12)	0.31* (0.13)
Desire for compensation		-0.18** (0.04)	-0.15** (0.04)		-0.25* (0.11)	-0.18 (0.13)
Desire for recognition		0.14 ** (0.04)	0.14** (0.04)		0.18 (0.12)	0.18 (0.13)
*Pleasure * Desire for compensation*			0.04 (0.04)			-0.05 (0.12)
*Challenge * Desire for compensation*			-0.13** (0.04)			-0.09 (0.12)
Log-likelihood				-382.91	-368.02	-367.38
Log-likelihood ratio χ^2				8.47†	38.25**	39.52**
Δ Log-likelihood ratio χ^2				8.47†	29.78**	1.25
Δdf[a]	4	4	2	4	4	2
R^2	0.02	0.08	0.09			
Δ R^2	0.02*	0.06**	0.01*			

[a] From the baseline model

† p<0.10

* p<0.05

** p<0.01

5.5.1. Effects of intrinsic motivation

Hypothesis 1 posits a positive relationship between the intrinsic motivations and the decision to contribute (see page 38). This hypothesis is fully supported. As seen in Table 6, pleasure and challenge have a positive significant coefficient for the decision to contribute (ß=0.31, p<0.05 resp. ß=0.34, p<0.001). So people that give more value to feelings of pleasure and challenge are more likely to become contributor. The effects of pleasure (odds=1.37) and challenge (odds=1.41) on the decision to contribute have similar sizes.

Hypothesis 2 states that intrinsic motives increase the quantity of contributions. This hypothesis is also supported since significant, positive coefficients for the relationships between pleasure (ß=0.28, p<0.01) and challenge (ß=0.41, p<0.01) and number of contributions are found. Note that the effect of the motive challenge is larger than the effect of the motive pleasure (IRR=1.51 and IRR=1.32, resp.).

Intrinsic motivations, as expected, do not show a significant relation with the usefulness of contributions. Finally, Hypothesis 3 states that intrinsic motivation will increase the novelty of contributions. This hypothesis is also supported since significant positive coefficients are found for the relation between pleasure and challenge and novelty (ß=0.29, p<0.05 and ß=0.31, p<0.05, resp.). The motives pleasure and challenge have a similar effect on the novelty of contributions (odds=1.34 and odds=1.36, resp.).

5.5.2. Effects of extrinsic motivation

The hypothesized effects of extrinsic motives are conditional on the presence or absence of rewards. Since Tweakers.net has an advanced reputation system stimulating participation and good performance, we expect, following Hypothesis 4a, to see positive effects related to the desire for receiving recognition on the decision to contribute. Since the reputation system of Tweakers.net rewards quantity, usefulness, and novelty, according to Hypothesis 4b, we also expect positive effects on each of these performance measures. We found significant positive coefficients for the relation with the decision to contribute (ß=0.17, p<0.10). So, Hypothesis 4a is supported.

We also found positive effects on usefulness (ß=0.16, p<0.001), but no significant effects on quantity and novelty. It should be noted that the effect of the desire for recognition on usefulness is rather small, since the R^2 is relatively low. In the usefulness scores a large number of zeros occurred, representing neutral scores and reactions that did not receive any scores. Excluding these zero counts improved the R^2 above 15%. Since positive effects

of the desire for receiving recognition are only found for usefulness, Hypothesis 4b is partially supported.

Tweakers.net does not provide any financial rewards for contributing to the community. According to Hypothesis 5 we expect that the desire for receiving financial compensation has a negative impact on the decision to contribute and on the quantity, usefulness and novelty of contributions. This hypothesis is partially supported since we found negative significant coefficients for the relation between the desire for compensation and quantity of contributions (ß=-0.18, $p<0.01$) and usefulness (ß=-0.16, $p<0.001$), but no significant effects on the decision to contribute and novelty.

5.5.3. Interplay between extrinsic and intrinsic motivation

Hypothesis 6 predicts a negative interaction effect between extrinsic and intrinsic motivations in terms of the enhancing (undermining) effects that intrinsic motives have on the participation and performance of contributors with low (high) extrinsic motivation in the absence of rewards (see page 40). Since Tweakers.net does not provide financial rewards, we tested for interaction effects of the desire for compensation and intrinsic motives on performance. In our analysis we found positive and negative interaction effects of intrinsic motives and desire for compensation. Positive coefficients are found in the interaction of challenge and desire for compensation on the decision to contribute (ß=0.20, $p<0.05$) and pleasure and desire for compensation on quantity (ß=0.19, $p<0.01$). Negative coefficients are found for the interaction of pleasure and desire for compensation on the decision to contribute (ß=0.19, $p<0.05$), and of challenge and desire for compensation on quantity (ß=0.21, $p<0.01$) and on usefulness (ß=-0.13, $p<0.01$).

To check for the robustness of interaction effects, we ran additional regressions. We left out of the models – which included the control variables, direct and interaction effects – one of the significant interaction effects. It appeared that the negative interaction coefficients of desire for compensation and challenge on the quantity and usefulness of contributions were robust. The other interaction effects – the effect of desire for compensation and pleasure on the decision to contribute and on quantity, and the effect of desire for compensation and challenge on the decision to contribute – disappeared when we did not include the other interaction effects, and thus were not robust (the signs for significance are between parentheses in Table 6).

In the first and higher order effects of challenge and the desire for compensation on quantity are presented. The estimated number of contributions follows the form: $\lambda_i=\exp(c+ß_1x_i+ß_2z_i+ß_3x_iz_i)$. It appears that for contributors with a low desire for compensation (extrinsic motivation), feelings of challenge have a stronger effect on the quantity of contributions than for contributors with a high desire for compensation. The figure shows that the difference for people with a high appreciation for challenge is very large, indicating that people with low extrinsic motivation and high intrinsic motivation provide a very high number of contributions.

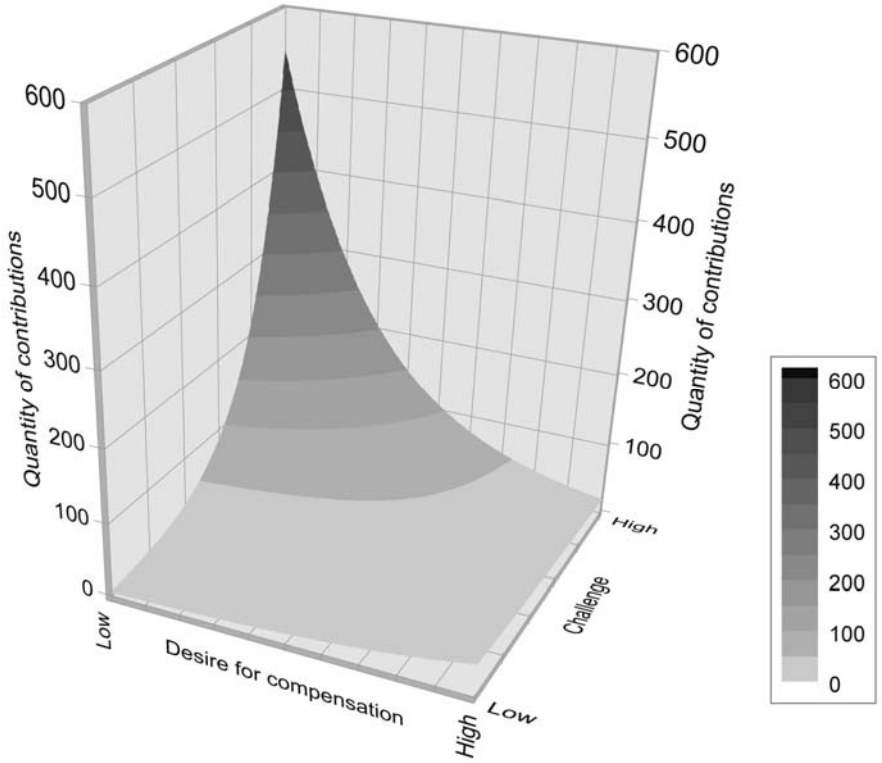

Figure 8 First and higher order effects of desire for compensation and challenge on quantity – Tweakers.net

In Figure 9, the first and higher order effects of challenge and the desire for compensation on usefulness are plotted. The figure follows the form: $P(Y_i)=c+ß_1x_i+ß_2z_i+ß_3x_iz_i$ (Aiken and West, 1991). It can be concluded that feelings of challenge have a positive effect on usefulness for contributors with a low desire for compensation, while they have a negative effect for people with high desire for compensation. As a consequence, people with a low desire for compensation and highly motivated by challenge provide more useful contributions than people with high extrinsic motivation and highly motivated by challenge.

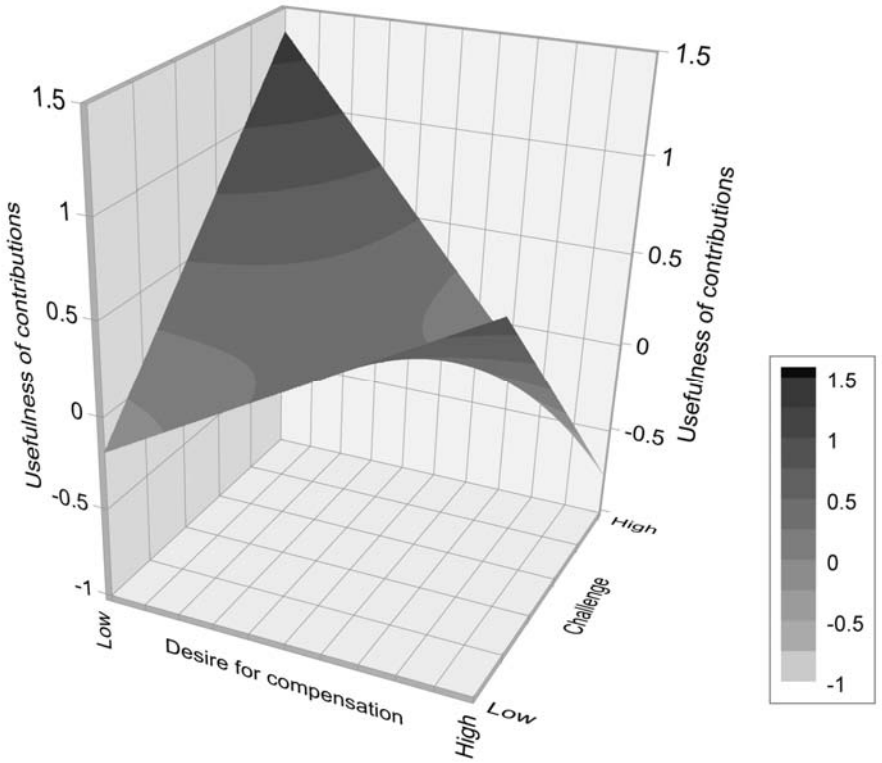

Figure 9 First and higher order effects of desire for compensation and challenge on usefulness – Tweakers.net

Additional regression analyses on the split datasets (low and high desire for compensation) confirmed the results as shown in Figure 8 and Figure 9.

So, we conclude that Hypothesis 6 is supported for the quantity of contributions and usefulness of contributions, and is not supported for the decision to contribute and for the novelty of contributions.

5.6. Conclusions

5.6.1. Summary of main findings

Based on an empirical study of 1,095 members of an online community we examined how motivations effect participation and performance in voluntary online activities. In support of our conceptual model, we found that intrinsic motivation is an important driver of voluntary contributions to an online community. Intrinsic motives have a positive effect on the decision to contribute, the quantity and the novelty of contributions. As expected, no effects of intrinsic motives on usefulness were found. We also found evidence that the effects of extrinsic motives are dependent on the presence or absence of rewards. In the situation that a reward was provided, extrinsic motives related to this reward appeared to have a positive effect on behavior, particularly usefulness. In the Tweakers.net community usefulness had a positive effect on the contributor's recognition since the ratings of staff and visitors of Tweakers.net contributed to the contributor's ranking. The extrinsic motive, desire for compensation, appeared to have a negative direct effect on quantity and usefulness. So, when rewards were absent, extrinsic motives related to these potential rewards had negative effects on quantity and usefulness. We explain this negative effect based on the negative, dissatisfied feelings of people with a high extrinsic motivation for a reward that was not provided. In general, these results confirm our expectation that intrinsically motivated contributors are more committed and produce more contributions, but they are led more by their own aims, particularly novelty, than extrinsically motivated contributors, who are more strongly led by the usefulness of their contributions for other people. Moreover, the results show that the more extrinsically motivated people are the fewer and less useful contributions they provide when rewards are absent.

An important caveat of our analysis is in the interplay of intrinsic motivation, extrinsic motivation and rewards. We found that intrinsic motivation had a stronger positive effect on the quantity of contributions when combined with a low desire for compensation (not rewarded extrinsic motivation) than when combined with high extrinsic motivation. In other words, intrinsic motivation has a positive effect on quantity for all contributors, but in the absence of rewards this effect is stronger for people with low extrinsic motivation, and weaker for people with high extrinsic motivation. Intrinsically motivated contributors with a low desire for compensation also provided more useful contributions, while intrinsically motivated contributors with high extrinsic motivation provided less useful contributions. Apparently the absence of rewards strengthens feelings of autonomy in people with low extrinsic motivation, leading to higher quantity and usefulness of contributions, and signals unimportance of the task to people with high extrinsic

motivation, leading to a reduced number of contributions and even a negative effect on their usefulness. Our results provide strong indications that the effects of rewards depends on a person's motivation levels in the sense that the absence of rewards is positive for people with high intrinsic motivation and low extrinsic motivation, and negative for people with high intrinsic motivation and high extrinsic motivation.

As a consequence of the direct effects of intrinsic and extrinsic motivation mentioned above and the interplay between motivations, two potential groups of high performing contributors exist. In the presence of rewards, contributors with high intrinsic and high extrinsic motivation perform best with respect to the combination of quantity and usefulness. In the absence of rewards, contributors with high intrinsic and low extrinsic motivation perform best with respect to both these two performance outcomes. The choice to have rewards or not thus affects the group of contributors with the highest contributions. We did an additional analysis and compared the two groups in our case, which means the contributors with high intrinsic motivation and high desire for recognition (rewarded extrinsic motivation) and the contributors with high intrinsic motivation and low desire for compensation (not rewarded extrinsic motivation), and we found that the second group performed better in terms of quantity and usefulness. Although the effects of the desire for recognition and desire for compensation cannot be directly compared, this would suggest that not having rewards would have better effects on quantity and usefulness.

We did not find support for all of the expected effects of motivation on specific performance aspects. For instance, we only found negative effects from the desire for compensation on quantity and usefulness, not on the decision to contribute and on novelty. The reason may be that the dissatisfying effect of the absence of rewards mainly applies to energy-consuming aspects of behavior such as repeated action and dedicating attention to the value of activities for others, thus to the quantity and usefulness of contributions. Those aspects of behavior will suffer more from dissatisfaction in the absence of rewards than the one-time decision to contribute and the generation of novelty in the contribution, which, as we saw above, depends more on intrinsic motives.

5.6.2. Theoretical implications

Our results have strong implications for the online and open source literature. The majority of current literature on motivations of online community members consists of the identification of self-reported motives for participation. We provide five contributions to this literature. First, we improve the analysis of effects of motivations on voluntary behavior by using actual and independent data on participation and output gathered from the systems of the firm instead of self-reported contributions or intentions for future behavior (Füller, 2006; Shah, 2006). Second, we investigate multiple performance aspects instead of the single performance measure quantity of contributions (Lampel and Bhalla, 2007; Füller, 2006). Herewith we can show that motivations have different effects on different performance outcomes. For example we show that extrinsic motivations affect the usefulness of contributions, while intrinsic motivations don't. Third, we investigate motivations of non-contributors or the so called lurkers. Thus, we create knowledge on which motivations are relevant for turning a non-contributor into a contributor. Fourth, we demonstrate the importance of the presence or absence of rewards on the effects of extrinsic motives on behavior, a condition often neglected in this literature (Füller, 2006; Wasko and Faraj, 2005). Finally, we also investigate interaction effects of intrinsic and extrinsic motives which is not only new to online and open source literature but also to the psychology literature.

These interaction effects have major implications for the debate in the psychology literature on the effects of rewards on voluntary behavior. The psychology literature has so far focused on the direct effects of rewards on behavior, mediated by motivation. An exception is Vansteenkiste et al. (2004), who studies the interaction between an autonomy-supportive climate and intrinsic goals on performance. We take a step further and study rewards as a moderator of the effects of motivation, and of the interaction of different types of motivations, on performance. We show that part of the effect of intrinsic motivation is irrespective of rewards, and that another part of the effects, both positive and negative, depends on the availability of rewards. For instance, rewards stimulate people with high extrinsic motivation to participate, and improve the usefulness of their contributions. On the other hand, the absence of rewards increases the quantity and usefulness of contributions of people with high intrinsic motivation related to challenge and low extrinsic motivation, which is in line with the positive effects of autonomy claimed by Deci et al (1999). Alternatively, the absence of rewards decreases the performance of people with high intrinsic motivation related to challenge and high extrinsic motivation, which supports the negative effects claimed by Eisenberger et al (1999a) and Eisenberger et al (1999b). We are thus able to explain the reported seemingly contrarian positive and

negative effects of rewards reported in the psychology literature. Also, our research shows that, contrary to current practice which investigates the direct effects of rewards on voluntary behavior, these effects should be investigated in combination with levels of intrinsic and extrinsic motivation. Finally, while the psychology literature discusses the influence of intrinsic and extrinsic motives on voluntary activities in general, we show that subcategories of intrinsic and extrinsic motives should be distinguished, since challenge seems to be more powerful than pleasure, at least in an online context. We also show the importance of the desire for recognition as an extrinsic motive, whereas the psychology literature research on voluntary behavior mainly focuses on the desire to receive financial compensation as reward (e.g. Deci et al, 1999; Eisenberger et al, 1999).

5.6.3. Managerial implications

This study is most relevant for firms using voluntary contributions of online community members. As sketched before, these firms struggle with the question of how they can balance quantity, quality and novelty of contributions. Since our results show that rewards not only have different effects on different performance aspects, but also that their effects are more complex than a simple positive or negative effect, firms should carefully design their reward systems. Our results suggest that a firm can follow two strategies: creating rewards and relying on the quantity and usefulness delivered by contributors with high intrinsic and high extrinsic motivation, or not having rewards and relying on the quantity, usefulness and novelty generated by contributors with high intrinsic and low extrinsic motivation. It seems that the first strategy is the most successful one. Without incurring the cost of any rewards, high intrinsically and low extrinsically motivated people provide the highest number of contributions that at the same time have high usefulness levels. Figure 10 illustrates that high intrinsically and low extrinsically motivated people provide quantities over 500 when rewards are absent, while high intrinsically and extrinsically motivated contributors provide a maximum 140 contributions in the presence of rewards (see Figure 11).

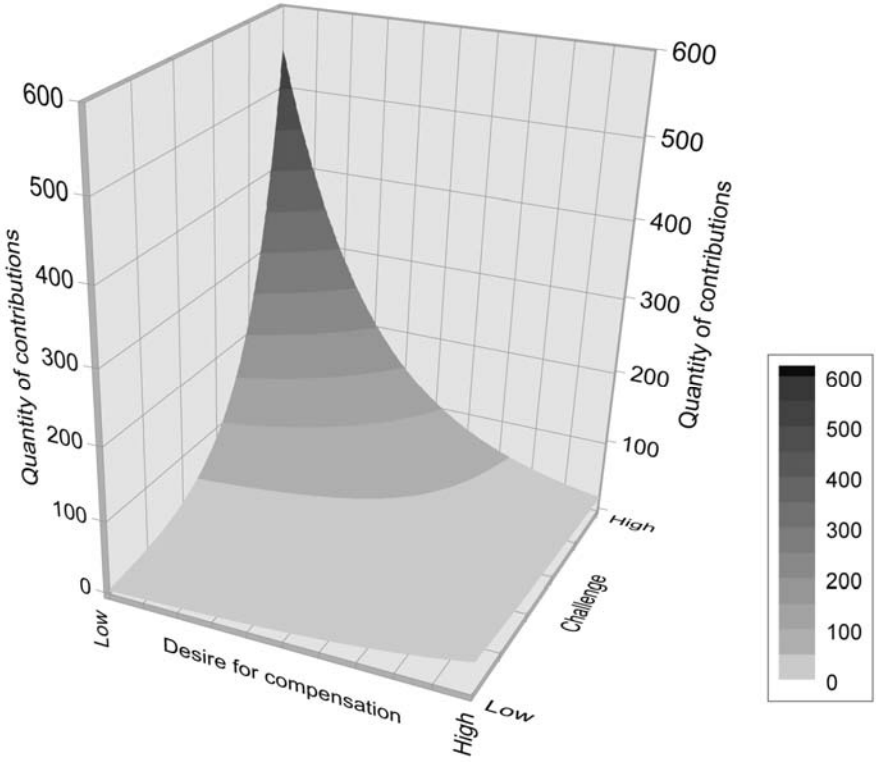

Figure 10 Expected effects of intrinsic and extrinsic motivation on quantity in absence of rewards

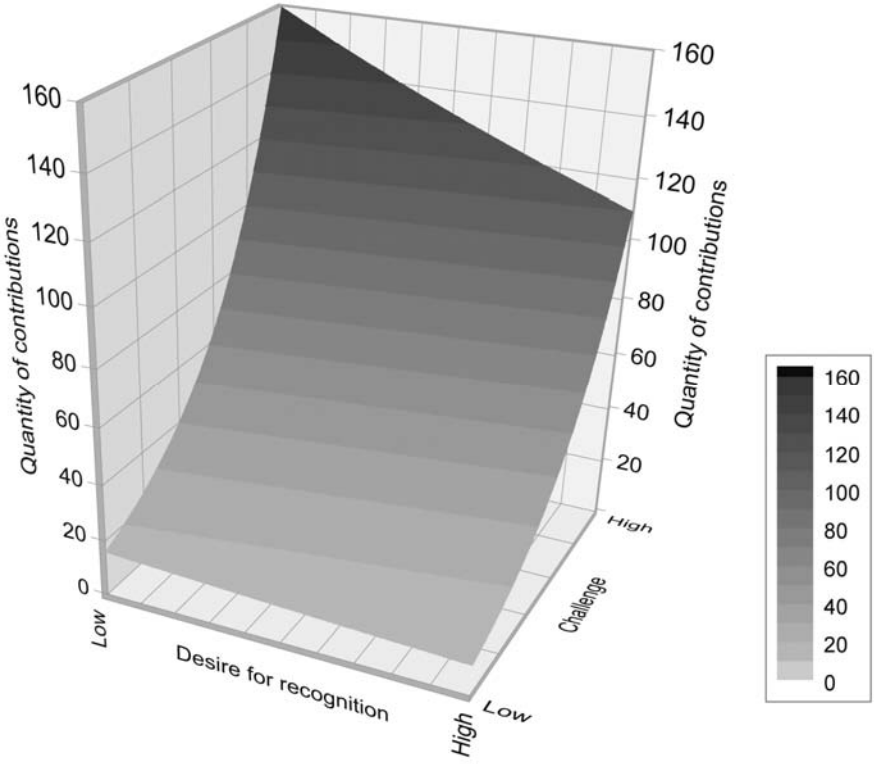

Figure 11 Expected effects of intrinsic and extrinsic motivation on quantity in presence of rewards

Similar conclusions can be reached for the usefulness of contributions: high intrinsically and low extrinsically motivated contributors score higher on average usefulness of their contributions in the absence of rewards than high intrinsically and extrinsically motivated contributors in the presence of rewards (see Figure 12 and Figure 13).

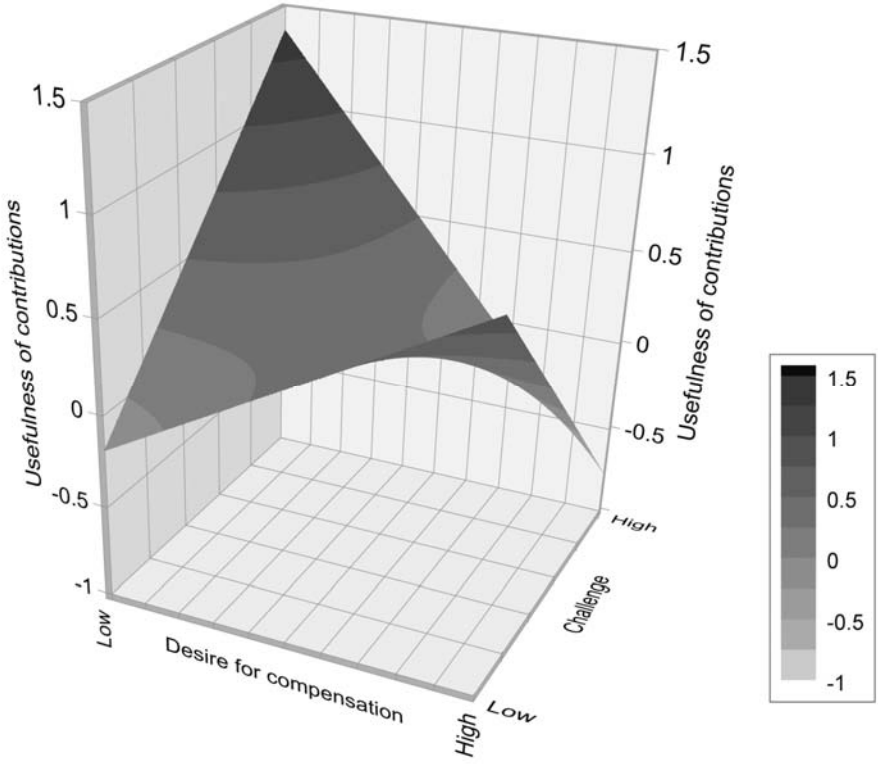

Figure 12 Expected effects of intrinsic and extrinsic motivation on usefulness in absence of rewards

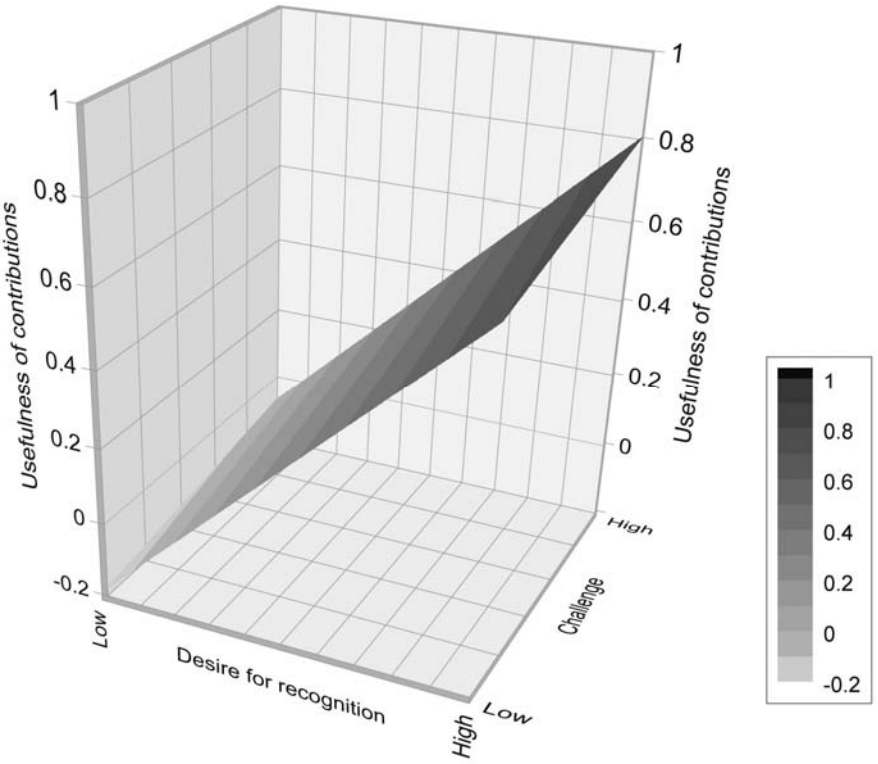

Figure 13 Expected effects of intrinsic and extrinsic motivation on usefulness in presence of rewards

We also investigated the size of the two groups of contributors in terms of motivation related to challenge and desire for compensation. These groups were then studied in order to determine the cumulative quantity and usefulness that each group provided.

The group with high challenge related motivation and a low desire for compensation was formed by picking out those contributors that have a challenge score above its mean and a desire for compensation score below its mean.

The group with high challenge related motivation and a high desire for recognition consists of respondents with scores above the mean score for these two motivation variables.

It appeared that the group of respondents with high challenge related motivation combined with a high desire for recognition is substantial larger (+85%) than the group of contributors with high challenge related motivation and a low desire for compensation. Despite lower quantities and usefulness per person, the high intrinsic and extrinsic motivated group provides together more contributions (+56%) and larger numbers of useful contributions (+12.5%) due to size effects. These results are summarized in Table 8. Therefore our study suggests that the first strategy, in which rewards are used, creates the best performance. Note that the costs for rewards should be taken into account when determining the strategy; the costs of rewards should offset the gain in size effect.

Table 8 Comparison of quantity and usefulness for groups with different motivations profiles

	High challenge ***Low desire for compensation***	**High challenge** ***High desire for recognition***
Total contributors in this (group)	179	329
Average quantity	36.7	31.13
Total quantity in this segment	6,570	10,242
Average usefulness	0.45	0.28
'Total' usefulness in this segment	63.1	71.1

For both strategies, the firm should spend efforts in reaching the right group of people. In all cases, the firm's communication should emphasize that the activity is fun and provides interesting challenges. On top of that the firm should emphasize either the benefits and rewards or the autonomy associated with participating in this community.

5.6.4. Limitations

Although this study had a high response rate (37%) and a high number of respondents (1,095), a first and clear limitation of this study is the empirical setting of a single online community. The fact that this community had a reputation system and no financial rewards may have served as a selection mechanism for participants. Although this does not necessarily affect the relation between motivations and behavior, the topic of this study, future research should cover more online communities with different reward systems.

Second, the comparison of a larger number of online and open source communities can also strengthen the contribution to the discussion of rewards in the psychology literature. We investigated the effects of motives on behavior in the presence and absence of two different types of rewards: financial compensation (absent) and reputation systems (present). The results indicated that the debate in the psychology literature might be solved by reference to specific groups of contributors who may have the behavior indicated by either group of scholars. Coincidental selection of participants in experiments may have been a reason for the differences in results so far. Future research should confirm whether the direct and interaction effects of desire for compensation are similar to the effects of desire for recognition when relevant rewards are offered. Such research may also show the effects of a variation in the size of rewards, since some authors argue that smaller rewards will have different effects than substantial rewards (Eisenberger et al, 1997; Gneezy et al, 2000).

Chapter 6. Case 2: NUfoto.nl

6.1. Introduction to NUfoto.nl

The second study is executed in the community NU.nl. Ilse Media founded NU.nl in 1999 and is the most popular Dutch news site offering news items in text, photo and video format. The site is number 7 in the ranking of top 100 Dutch websites in terms of traffic statistics[26]. The site includes several subsites. For example NUjij.nl is a forum where visitors can discuss news items, NUsport.nl shows exclusively sports news, NUtvgids.nl provides information on programs per television channel and NUfoto.nl publishes new photos produced by visitors (citizen news photography).

Our research is focused on the photos uploaded at NUfoto.nl. Since 2002, visitors of NU.nl are able to upload newsworthy photos on its website. These photos were first published on the NU.nl site where it was very successful which resulted in capacity constraints[27]. Since August 2007, a subsite dedicated to newsphotos came into force to enlarge the capacity for user generated photos[28]. According to the chief editor of NU.nl the quality of the user generated news photos and the interest of visitors for these photos is high[29]. NU.nl also acknowledges that citizen news photography can result in more speedy publishing of news photos. In order to facilitate fast uploading, NU.nl developed a photo application for the iPhone which enables all contributors of NUfoto.nl to directly upload their photos[30].

The user generated photos represent advertising value to NU.nl. The estimated value of NUfoto.nl, created by its contributors, in December 2009 is USD 70,000[31]. Besides the advertising revenues from the subsite, NUfoto.nl, potential revenues from the reselling of news photos to press agencies, is foreseen. The editorial board of NUfoto.nl sends a daily selection of photos with high news value to ANP (Dutch press agency) with the intention to resell these[32].

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26 www.Alexa.com, downloaded June 2010

27 http://www.digitalefotografietips.nl/nieuws/nunl-lanceert-nufotonl/

28 http://www.ilsemedia.nl/en-web-Nieuws-Persberichten-2007-15082007.php

29 http://twinklemagazine.nl/nieuws.aspx?id=8460

30 http://www.nederlandsmedianetwerk.nl/profiles/blogs/nunl-lanceert-iphoneapp-voor

31 http://www.cubestat.com/www.nufoto.nl

32 http://www.ilsemedia.nl/en-web-Nieuws-Persberichten-2005-18052005.php

NUfoto.nl installed a new platform enabling user generated content in August 2007. Half a year later more than 1,500 persons had uploaded over 25,000 photos. In March 2008 NUfoto.nl generated more than 3.5 million page views per month. In the mean time the number of page views increased to 5.5 million per month in December 2009[33]. Not only are photos of Dutch news events uploaded, but also photos of foreign events. Popular themes are 112 news, celebrities and public or sports events.

Before a visitor can upload a photo he or she has to register. For the registration to be successful, the name, address and email address have to be provided and the General Terms and Conditions of NUfoto.nl must be accepted. The General Terms and Conditions specify rules regarding ownership of the photo, right for publication and liability. It should be noted that a substantial percentage of registered visitors (about 45%) do not upload a single photo. We assume that these persons have the intention to upload, but finally decided, for whatever reasons, not to publish their photos on the site.

The uploading of a photo is a simple activity: after log-in you can browse through your files on your computer. It is indicated at the webpage that photos must be in JPG, GIF or PNG format and a maximum size of 5 Mb. The webpage also summarizes criteria for publication:

- The person uploading the photo has to be the photographer;
- Manipulated or photo-shopped photos are not allowed;
- Copyrighted photos are not allowed.

Next the contributor can add information about the uploaded photo such as title, date, a brief description of the news item photographed, news photo category and key words (meta-data). The location of the news event can be indicated on Google Maps.

Uploaded photos are screened by the editors of NUfoto.nl before publishing. Photos with detrimental content or manipulated photos are removed[34]. The remaining photos are categorized and published on the website.

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[33] http://www.sanoma-adverteren.nl/nl-web-Onze_media-n-NUfoto.nl-online-Profiel-Merk_profiel.php

[34] http://www.toekomstvandejournalistiek.nl/2009/09/knutselfoto-op-nunl/

6.1.1. Financial rewards

By accepting NUfoto.nl's terms and conditions, a person gives NU.nl the right to publish uploaded photos on the website and also at other sites owned by Ilse Media. In addition, NU.nl is granted the right to transfer photos to third parties, for example press agencies. When NU.nl sells a photo to an external party, the person that produced this photo received, in 2007, a 50% revenue share. Recently this percentage increased to 100% (after reduction of costs). According to the publisher of NU.nl, a photographer earns about € 50 per photo sold. In 2007, about fifteen photos were sold to external parties[35]. So the chance to actually receive financial compensation for an uploaded photo is very low (smaller than 0.05%).

6.1.2. Reputation rewards

Besides the possible monetary benefits, NU.nl also provides reputation enhancements. Contributors are allowed to compose a personal profile. The name of the photographer is published together with his or her photo. A list of five top photographers is published on the front page of NUfoto.nl. The ranking of top photographers is based on the number of page views that their photos generate. The list shows that the number of page views is not fully dependent on the number of uploaded photos. For example the number 1 photographer (690,000 page views, 808 uploaded photos) provided less contributions compared to number 2 (138,000 page views, 1855 uploaded photos) and number 3 (121,00 page views, 1506 uploaded photos). The photos of top photographers depict 112 news items or show celebrities. All photos are of good quality.

A last reputation reward that NUfoto.nl uses is an annual contest for the best news photo of the year. A pre-selection of 100 photos, based on number of page views, is rated by visitors of the NUfoto.nl site. The 10 photos with the highest ratings are judged by an expert jury of professional and well known news photographers. The three winners of the contest receive publicity and a relatively small tangible prize (an enlargement of their photo).

6.1.3. Reward criteria

Tweakers.net used a reward system with well defined criteria which are published at the website. Furthermore, the rewards criteria addressed the four participation and performance measures that we included in our hypotheses. In the NUfoto.nl study, reward criteria are less clear and not always related to our full set of participation and performance measures.

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[35] http://www.mediafacts.nl/dossiers/1_Binnenlands_nieuws_actueel/artikel/3926_Nu_scoort_met_lezersfoto

Although NUfoto.nl informs its registered visitors on the possibility of receiving a financial reward, no information is provided on which photos qualify for receiving this reward. NUfoto.nl issued a press release when photos, showing the arrest of a well known criminal, were sold to over five news services. Indirectly it can be concluded that the photos were sold not because of their quality, such as sharpness and composition, but because of their uniqueness: no professional photographers had photos of this news item. Non-professional photographers do not have an overview whether they have the one and only picture of the news event and can only check this when uploading and publishing their materials. Therefore criteria for receiving financial reward is more related to the decision to contribute and quantity than for example novelty.

Criteria for rating and the selection of the winners of the annual contest for the best photo of the year are not published. NUfoto.nl only informs its audience that the pre-selection of candidates for the contest is based on the number of page views. Therefore receiving the reputation rewards (i.e. win the prizes of the annual contest) is more related to usefulness then for example novelty of photos.

6.1.4. Hypotheses testing

Contributors of NUfoto.nl have a chance to receive financial and reputation rewards. So in this study, there is no absence of rewards. Hypothesis 5 in which we describe our expected first order effects of extrinsic motivation on participation and performance in the absence of rewards is therefore not tested in this study. Despite the fact that we do not expect interaction effects in the absence of rewards (based on hypothesis 6), we still analyze possible interaction effects for reasons of completeness.

The fact that in this study the reward criteria are not related to all performance aspects influences the testing of hypothesis 4a and 4b on the effects of extrinsic motivation in the presence of rewards (see paragraph 3.2.2).

6.2. Data collection NUfoto.nl

We collected data from different sources: a websurvey among registered visitors of NUfoto.nl and archival data gathered at NUfoto.nl. Since no information on the novelty of uploaded photos was available, we asked an expert jury to provide this data.

An invitation to the websurvey was sent to 3,396 visitors who were registered at NUfoto.nl in December 2007. More than 50% of these registered persons (1,893 persons) had uploaded one or more photos in the period August 2007 through December 2007; 1,503 persons did not upload a photo in this period. After one week a reminder was sent to the non-respondents.

It appeared that 24 contributors and 94 non-contributors could not be reached due to invalid mail addresses or technical problems. 621 (33%) contributors started the websurvey and 516 (28%) contributors completed the survey. 279 (20%) non-contributors started the websurvey and 170 (12%) non-contributors completed the survey. Differences in response rates confirm that those more involved in the community are more likely to respond to the survey than others (Groves et al, 2000).

Again we eliminated data of respondents who provided the same answers to at least 80% of the questions. As a result data of 459 contributors and 147 non-contributors was used in all subsequent analysis. In total, 605 datasets were analyzed.

Despite the satisfactory response rate, we checked for possible self-selection by comparing the responses of late respondents with early respondents (Armstrong and Overton, 1977). The independent samples T-tests of respondents before reminder and after reminder showed no significant differences in mean scores for the four motives. The significance levels of the two-tailed t-test were all well above the 20%.

Data on the dependent variables (decision to contribute, quantity and usefulness) were derived from the systems of NU.nl. This data is covers the months August 2007 through December 2007. We have chosen to use data from more than one month, since the numbers of contributions to online communities per contributor is quite skewed (Lerner and Tirole, 2002). Therefore a longer period, in our case a five month period, better reflects the differences in quantities between longer term active contributors and one-off contributors.

In addition, NU.nl provided a random selection of two photos per respondent. These photos were used in the novelty assessment by an expert panel.

6.3. Measurement of variables

In the NUfoto.nl study, the dependent variables were the participation measure 'decision to contribute' and the performance measures quantity, usefulness and novelty. The independent variables were the intrinsic and extrinsic motives of respondents and a selection of control variables.

6.3.1. Decision to contribute

We distinguished between non-contributors and contributors on the basis of the number of contributions. Similar to the Tweakers.net study, non-contributors did not upload any photo while contributors uploaded at least one photo in the period August 2007 through December 2007. The number of photos uploaded per respondent, were derived from the systems of NU.nl.

6.3.2. Quantity of contributions

Similar to the Tweakers.net study, we used the number of contributions as a measure of quantity. Based on archival data, NU.nl provided us with counts of the number of photos that the respondent (identified by his or her email address) uploaded in the period August 2007 to December 2007 (three months period).

6.3.3. Usefulness of contributions

As a measure of usefulness for other visitors of NUfoto.nl, we used the number of page views that photos of a respondent generated on average. We assume that the more useful a photo is, the more page views it generates. The count data on page views per respondent were derived from the systems of NU.nl and divided by the number of photos that a respondent had uploaded.

6.3.4. Novelty of contributions

Although NU.nl selects each year the best new photo uploaded at NUfoto.nl, the novelty of the photos of NUfoto.nl is not systematically assessed. No peer-rating system was available during the time of our study. Instead we used an expert panel consisting of three (semi) professional photographers. These experts assessed the novelty of the randomly selected photos per respondent (with a maximum of 2 photos per respondent) using three criteria: newness of the way an item is caught in the photo, newness of form or composition and the newness of the selected subject. For each criterion a score on a 1 to 10 scale was provided. Our measure of novelty was the mean of the three scores.

In order to maximize consistency and agreement within the expert panel, criteria for novelty were discussed with the panel members before starting the assessment. Experts first scored 45 photos and the intraclass correlation (ICC) of these scores was checked. The ICC computed for novelty is 0.83 with a 95% confidence interval running from 0.75 to 0.90. As an ICC of 1.00 would indicate perfect agreement, we can consider the level of agreement among the experts as acceptable. Next each expert scored a third of the remaining photos (about 250 photos per person).

6.3.5. Motives

For the measurement of motivation we used the Work Preference Inventory (Ambile et al, 1994). The statements were contextualized in such a way that it measures the motivation for the production and uploading of news photos. For example the original statement "I am strongly motivated by the money that I can earn" is adjusted to "I am strongly motivated by the money that I can earn in the publishing of self-produced photos".

Since we expected a negative effect of an English questionnaire on the response rate (NUfoto.nl uses the Dutch language exclusively) the questionnaire was translated in Dutch. To guarantee a good translation, the questionnaire was translated back into English by an English person that was unfamiliar with the original questionnaire. A comparison of the re-translated questionnaire and the original questionnaire demonstrated that the items did not change due to translation.

Each item had to be scored on a 6 point Likert scale. The complete survey was pre-tested on 15 persons and small improvements in language were made on the basis of the feedback from the testers. For the complete survey see Annex C.

6.3.6. Control variables

In the websurvey, a limited number of questions on demographic characteristics such as gender, age, nationality, educational background and employment status were included. These characteristics served as control variables since research indicates that these demographic characteristics are drivers of voluntary behavior in offline activities (Day et al, 1996).

6.3.7. Validity

Prior to testing the hypotheses, we conducted a confirmatory factor analysis to examine the distinctiveness of the motivation measures used in this study. The initial estimated confirmatory factor model showed model fit statistics below acceptable levels (χ^2=2337.13 [344, n=606]; p<0.01; RMSEA=0.10; CFI=0.89; SRMR=0.09).
Subsequently we executed a specification search to arrive at the model that correctly represents the network of relations among manifest and latent variables (Diamantopoulos and Siguaw, 2000). The specification search resulted in the deletion of items that caused cross loadings. The adjusted CFA model showed a sufficient fit (χ^2=311.41 [71, n=606]; p<0 .01; RMSEA=0.08; CFI=0.96; SRMR=0.05).

For completeness, we compared this higher-order four-factor model structure to three- and two-factor structures. In the three-factor models the two intrinsic or the two extrinsic motives are taken together in one factor while in the two-factor model intrinsic and extrinsic motives serve as the two remaining factors. Runs of the three- and two-factor models showed that the Expected Cross Validation Index (ECVI) and Consistent Akaike's Information Criterion (CAIC) values increased as compared to the higher order, four factor model. This provided support for a four-factor model (Diamontopoulos and Siguas, 2000).

Since the composite reliability of each factor of the final CFA model is greater than 0.60, the items provide a reliable measurement of each factor (Diamontopoulos and Siguas, 2000). The values of average variance extracted are larger than 0.50. So a substantially higher amount of variance in the items is captured by the factor compared to that accounted for by the measurement error (Diamontopoulos and Siguas, 2000).

6.4. Analysis methods

Similar to the Tweakers.net study, the dependent variables were of different types with different distributions. In this study, we also had to use multiple statistical models for hypothesis testing. For the variable novelty we used linear regression. For the other variables, quantity and usefulness, negative binomial regression was used because these count data was overdispersed (Cameron and Trevedi, 1998; Hilbe, 2007). A likelihood-ratio test of overdispersion indicated that negative binominal regression was an appropriate choice. Again a hurdle model was used for variables decision to contribute and quantity. The binary process (logit model) provides results on our hypothesis decision to contribute since it compares positive counts (1) versus zero counts (0). The zero truncated negative binomial model was used to model the positive counts and provides a forecast of the number of contributions per contributor. For the analysis of the variable usefulness, expressed as the number of page views, the standard negative binomial regression was used.

Similar to the Tweakers study we followed a stepwise approach in our regression analysis. In the first step, the five control variables were included. In the second step we added the motivation variables. Although we do not expect any interaction effects between intrinsic and extrinsic motivation since only rewards are present, we still check for these effects for reasons of completeness.

6.5. Results

Table 9 lists the means, standard deviations and correlations for the variables.

Table 9 Descriptive statistics and correlations – NUfoto.nl

Variable	N	Mean	s.d.	1	2	3	4a	5	6 a	7 a	8 a	9	10	11	12
1. Quantity	606	11.70	32.36												
2. Usefulness	453	1151	2736	-0.04											
3. Novelty	452	3.61	1.14	0.07	0.07										
4. Gender [a]	606			-0.06	0.07	-0.07									
5. Age	606	37.4	13.1	0.04	-0.03	-0.04	0.01								
6. Education [a]	606			-0.03	-0.09*	0.02	0.07	0.03							
7. Relevant education [a]	606			-0.05	-0.08	0.08	-0.04	0.09*	-0.07						
8. Relevant working experience [a]	606			-0.11**	-0.10*	-0.15**	0.07	0.01	-0.02	0.36**					
9. Pleasure	606	2.86	0.88	0.12**	-0.05	0.09*	0.07	-0.04	-0.13**	-0.14**	-0.16**				
10. Challenge	606	3.72	0.89	0.08	-0.02	0.17**	-0.09*	-0.06	-0.13**	-0.18**	-0.24*	0.61**			
11. Compensation	606	3.04	1.28	0.13**	0.01	0.05	-0.04	-0.11**	-0.19**	-0.24**	-0.27**	0.52**	0.45**		
12. Recognition	606	3.00	0.63	0.07	0.02	0.12*	0.02	-0.19**	-0.13**	-0.12**	-0.15**	0.55**	0.56**	0.45**	

[a] For categorical data Spearman instead of Pearson correlations are shown

4. Gender dummy coded: 1 = male, 2 = female

6. Education dummy coded: 1 = secondary general education, 2 = higher secondary general education, 3 = higher or academic education

7. Relevant education dummy coded: 1 = no relevant education, 2 = relevant education

8. Relevant working experience dummy coded: 1 = no relevant working experience, 2 = relevant working experience

* $p<0.05$

** $p<0.01$

Two-tailed *t*-tests

Respondents have an average age of 37 years. The majority of respondents are male (83%). We received sufficient response of female members (over 100 female respondents) to include gender as a reliable control variable. The majority of respondents can be characterized as non-professional news photographers; only 14% of respondents indicated to have relevant education and 32% have relevant working experience.

The two intrinsic motives were highly correlated ($r=0.52$, $p<0.01$) while the correlation of the two extrinsic motives is substantially lower ($r=0.27$, $p<0.01$). The intrinsic and extrinsic motives are significantly and positively correlated. The correlation matrix shows that the correlations between the intrinsic motives pleasure and challenge and the extrinsic motive desire for recognition ($r=0.42$ respectively $r=0.42$, $p<0.01$) are higher than the correlations between the intrinsic motives pleasure and challenge and the extrinsic motive desire for compensation ($r=0.22$ respectively $r=0.30$, $p<0.01$).

Remarkable is that the majority of control variables are negatively correlated with motivation. Respondents with higher age, higher levels of education, more relevant education or more working experience show lower levels of intrinsic and extrinsic motivation.

The unstandardized means and standard deviations for the intrinsic motives, pleasure and challenge, and for the extrinsic motives, desire for compensation and desire for recognition, are listed in Table 5. Standardized variables were used in all regression analyses to overcome multicollinearity (Aiken and West, 1991). Through standardization of the motives, the maximum variance inflation factors (VIFs) obtained in any of the models did not exceed 1.5 and thus they were substantially below the cutoff value of 10 for regression models (Field, 2005).

We report the results of the negative binomial hurdle analysis in Table 10. In Table 11, the results of the negative binomial and linear regression are presented. Based on the log likelihood ratio test, we conclude that in the zero truncated negative binomial regression (dependent variable quantity), negative binomial regression (dependent variable usefulness) and linear regression analyses (dependent variable novelty), the full model – including control and first order – showed the best model fit. In the logistic regression, analyzing the decision to contribute, the model including only control variables showed the best fit.

Table 10 Results hurdle model – NUfoto.nl

	Logistic regression ***Decision to contribute***			**Zero truncated negative binomial regression** ***Quantity***		
	Model 1	*Model 2*	*Model 3*	*Model 1*	*Model 2*	*Model 3*
Constant	2.83** (0.72)	3.19** (0.79)	3.09 (0.80)	3.21** (0.68)	1.94** (0.69)	2.06** (0.66)
Gender	-0.54* (0.23)	-0.61* (0.24)	-0.64** (0.24)	0.05 (.24)	0.10 (0.23)	0.28 (0.24)
Age	-0.02* (0.00)	-0.02* (0.00)	-0.02* (0.00)	0.01* (0.00)	0.01* (0.00)	0.01* (0.00)
Education	0.07 (0.06)	0.07 (0.06)	0.08 (0.06)	-0.25** (0.06)	-0.19** (0.06)	-0.17** (0.05)
Relevant education	-0.07 (0.31)	-0.17 (0.32)	-0.14 (0.32)	-0.01 (0.24)	0.31 (0.23)	0.17 (0.24)
Relevant experience	-0.30 (0.22)	-0.35 (0.23)	-0.34 (0.23)	-0.57** (0.18)	-0.36* (0.18)	-0.30† (0.18)
Pleasure		0.11 (0.13)	0.11 (0.13)		0.19* (0.09)	0.14 (0.10)
Challenge		-0.02 (0.13)	-0.00 (0.14)		-0.01 (0.09)	0.02 (0.10)
Desire for compensation		-0.27* (0.12)	-0.30 (0.12)		0.32** (0.09)	0.37** (0.09)
Desire for recognition		0.16 (0.12)	0.20 (0.13)		0.05 (0.09)	0.13 (0.10)
*Pleasure * Desire for compensation*			-0.17 (0.12)			0.01 (0.09)
*Pleasure * Desire for recognition*			0.22 (0.14)			-0.32** (0.11)
*Challenge * Desire for compensation*			0.26† (0.13)			-0.10 (0.10)
*Challenge * Desire for recognition*			0.21† (0.12)			0.27(**) (0.09)
Log-likelihood	-328.27	-325.30	-322.65	-1586.54	-1572.47	-1569.32
Log-likelihood ratio χ^2	14.39*	20.31*	25.61*	27.93**	56.59**	71.20**
ΔLog-likelihood ratio χ^2	14.39*	5.92	5.30	27.93**	28.66**	14.61**
Δdf[a]	5	4	4	5	4	4
AIC						
BIC						
Dispersion parameter α				4.59	3.65	3.26

a. From the baseline model

† p< 0.10. * p <0.05. ** p <0.01

Table 11 Results negative binomial and linear regression – NUfoto.nl

	Negative binomial regression *Usefulness*			Linear regression *Novelty*		
	Model 1	*Model 2*	*Model 3*	*Model 1*	*Model 2*	*Model 3*
Constant	7.96** (0.61)	8.15** (0.61)	8.39** (0.59)	4.50*** (0.39)	4.30*** (0.41)	4.31*** (0.42)
Gender	-0.61** (0.20)	-0.67** (0.21)	-0.69** (0.20)	-0.17 (0.15)	-0.15 (0.15)	-0.14 (0.15)
Age	-0.01 (0.00)	-0.00 (0.00)	-0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Education	0.02 (0.05)	-0.00 (0.05)	-0.00 (0.05)	0.03 (0.03)	0.04 (0.03)	0.04 (0.03)
Relevant education	0.13 (0.22)	0.13 (0.22)	0.19 (0.22)	-0.06 (0.16)	-0.05 (0.16)	-0.02 (0.16)
Relevant experience	-0.21 (0.16)	-0.26 (0.17)	-0.36* (0.17)	-0.32** (0.12)	-0.28* (0.12)	-0.28* (0.12)
Pleasure		-0.15 (0.09)	-0.13 (0.10)		0.01 (0.07)	0.01 (0.07)
Challenge		-0.15 (0.11)	-0.13 (0.11)		0.16* (0.07)	0.11 (0.07)
Desire for compensation		0.15 (0.10)	0.07 (0.10)		-0.08 (0.06)	-0.07 (0.07)
Desire for recognition		0.16† (0.09)	0.18† (0.09)		0.07 (0.06)	0.03 (0.07)
*Pleasure * Desire for compensation*			0.02 (0.11)			0.18* (0.07)
*Pleasure * Desire for recognition*			-0.24* (0.12)			-0.08 (0.08)
*Challenge * Desire for compensation*			0.28(*) (0.11)			-0.12 (0.07)
*Challenge * Desire for recognition*			-0.04 (0.10)			0.00 (0.07)
Log-likelihood	-3480.08	-3475.60	-3468.65			
Log-likelihood χ^2	11.08*	20.05*	33.94**			
ΔLog-likelihood χ^2	11.08*	8.97†	13.89**			
Δdf [a]	5	9	13	5	4	4
AIC						
BIC						
Dispersion parameter α	2.28	2.25	2.20			
R^2				0.03	0.05	0.07
ΔR^2				0.03*	0.02*	0.02

[a] From the baseline model.

† p< 0.10. * p <0.05. ** p <0.01

6.5.1. Effects of control variables

As seen in Table 10 and Table 11, gender has negative coefficients for the decision to contribute (β=-0.61, $p<0.05$) and usefulness (β=-0.67, $p<0.01$). This means that female community members are less likely to become contributors and are expected to provide less usefulness contributions. It should be noted that the coefficients for the relation between gender and decision to contribute and usefulness are rather high; in the case of the analysis of usefulness this is, in fact, the highest coefficient. This means that gender is an important predictor in the decision to contribute and usefulness.

Relevant experience also has significant negative coefficients for quantity (β=-0.36, $p<0.05$) and novelty (β=-0.28, $p<0.05$). This means that, keeping all other items constant, as the relevant working experience of contributors increase, these contributors provide a lower number of contributions and less novel contributions. Although the coefficients are lower than the coefficients of gender, variable relevant experience, should also be considered as an important predictor of quantity and usefulness. Since the R^2 of linear regression on usefulness is relatively low, the explanatory power of the variables is limited.

The control variable age has significant coefficients for the decision to contribute and quantity (β=-0.02, $p<0.05$ respectively β=0.01, $p<0.05$). These coefficients are very small (odds=0.98 respectively odds=1.01) so that these effects can be ignored. Somewhat larger is the significant coefficient of education relative to quantity (β=-0.19, $p<0.01$).

6.5.2. Effects of intrinsic motivations

Hypothesis 1 posits a positive relationship between the intrinsic motivations and the decision to contribute. This hypothesis is not supported since the inclusion of intrinsic motivation variables did not result in a significant model change.

Hypothesis 2 states that intrinsic motivations increase the quantity of contributions. This hypothesis is partially supported since only the motive of pleasure shows a positive and significant coefficient (β=0.19, $p<0.05$). The motive of challenge has a negative coefficient but this relation is insignificant. Intrinsic motivation, as expected, does not show a significant relation with the usefulness of contributions.

Finally, hypothesis 3 states that intrinsic motivations will increase the novelty of contributions. This hypothesis is also partially supported since the motive, challenge, shows positive a significant coefficient for novelty (β=0.16, $p<0.05$). No significant relation is found between the motive of pleasure and novelty.

6.5.3. Effects of extrinsic motivations

The hypothesized effects of extrinsic motives are conditional on the presence or absence of rewards. In this study there is a chance of receiving a financial reward. By accepting the general terms and conditions, the contributor grants the editorial staff of NU.nl the rights to sell uploaded photos to external parties, such as press agencies. When NU.nl sells a photo, the revenue is shared with the photographer. Although the criteria for the sale of a photo are not explicitly communicated, it seems that the chance of selling a photo is not only dependent on its news value, but more importantly on the chance that professional photographers were not present at the news event. The latter is not directly visible for a non-professional photographer; he or she does not have an overview of the supply of professional photographers. Through uploading and the mediation of the editorial staff which offers photos to press agencies, is the uniqueness of a photo can be checked. In accordance with hypotheses 4a and 4b, we expect a positive relation between the desire for compensation and the decision to contribute and the quantity. Since the criteria for receiving the reward is, to a lesser extent, dependent on the usefulness of the picture, we do not expect a positive relation between the desire for compensation and usefulness. We observe that novelty, which we defined in terms of technical and/or artistic novelty, is not at all relevant for the chance of selling a photo. Therefore, we don't expect a positive relation between the desire for compensation and novelty.

The main reputation rewards that NU.nl offers are the top 5 list of photographers and the annual contest for the best NUfoto.nl photo. The top 5 list on the front page of NUfoto.nl shows the contributors with the highest number of page views. The 100 selected photos for the annual contest are included in an exhibition. The three winners receive publicity and a print of their winning photos. Criteria for the selection of the winners are not communicated; the pre-selection is based on the number of page views. We conclude that reputation rewards are to a large extent dependent on the page views. Since the uploading of photos is a condition to generate page views, we expect in accordance with Hypothesis 4a a positive relation between the desire for recognition and the decision to contribute. Following Hypothesis 4b we expect a positive relation between desire for recognition and the usefulness of contributions.

Since the optimal regression model analyzing the decision to contribute only included the control variables, no support for Hypothesis 4a is obtained. Conforming to our expectations, the desire for compensation has a significant positive coefficient on quantity (β=0.37, $p<0.01$) and the desire for recognition a significant positive coefficient on usefulness (β=0.18, $p<0.10$). As expected, the effects of the desire for compensation on

usefulness and novelty and the effects of desire for recognition on quantity and novelty are not significant. These results support Hypothesis 4b.

6.5.4. Interplay between intrinsic and extrinsic motivations

Hypothesis 6 on the interplay of intrinsic and extrinsic motivation in the absence of rewards could not be tested in this study, since both financial and reputation rewards are offered to contributors of NUfoto.nl. For reasons of completeness we also analyzed possible interaction effects.

In our regression analyses, we found positive and negative interaction effects of intrinsic motives and the desire for compensation or the desire for recognition. Positive coefficients are found in the interaction of challenge and the desire for recognition on quantity (β=0.27, $p<0.01$) and in the interaction of challenge and the desire for compensation on usefulness (β=0.28, $p<0.05$). Negative coefficients are found in the interaction of pleasure and the desire for recognition on quantity (β=-0.32, $p<0.01$) and on usefulness (β=-0.24, $p<0.05$).

To check for the robustness of interaction effects, we ran additional regressions. In our models – which included the control variables, direct and interaction effects – we left out one of the significant interaction effects. It appeared that the negative interaction coefficients of desire for recognition and pleasure on the quantity and usefulness of contributions were robust. The other interaction effects – the effect of desire for recognition and challenge on quantity and the positive interaction coefficient of desire for compensation and challenge on usefulness – were not robust. The sign for significance of the non-robust interaction effects are between parentheses in Table 10 and Table 11.

In Figure 14 and Figure 15 the first and higher order effects of pleasure and the desire for recognition on quantity and usefulness are presented. The estimated number of contributions and clicks per photo follow the form: $\lambda_i=\exp(c+ß_1x_i+ß_2z_i+ß_3x_iz_i)$. It appears that contributors with strong feelings of pleasure and a low desire for recognition provide higher quantities while contributors with strong feelings of challenge and a high desire for recognition are strongly and negatively influenced.

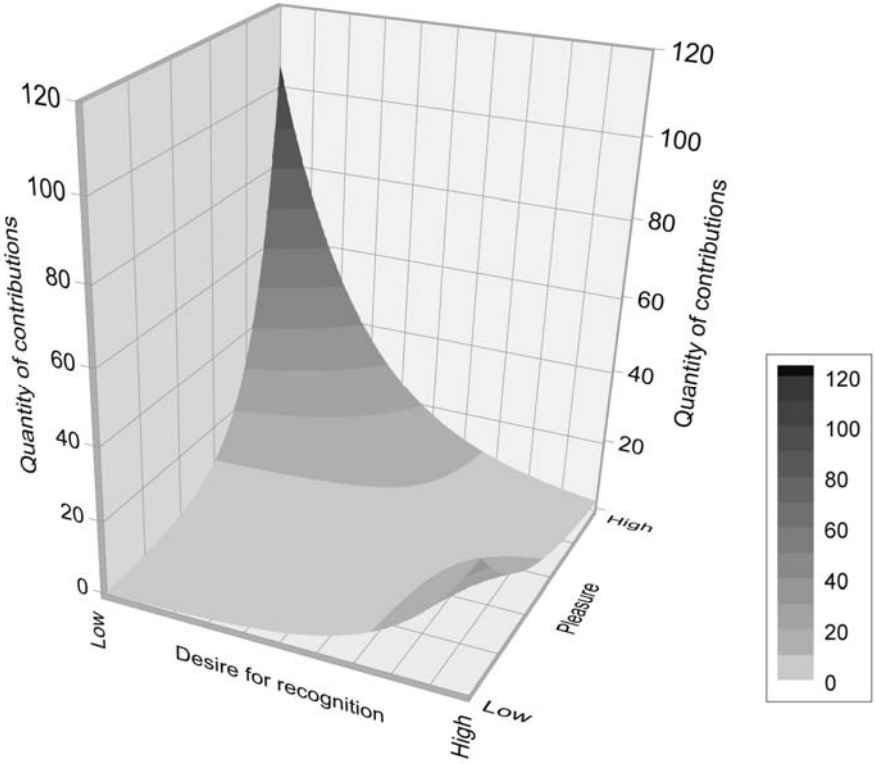

Figure 14 First and higher order effects of desire for recognition and pleasure on quantity – NU.nl

As can be concluded from Figure 15, contributors with low feelings of challenge and high desire for recognition provide more useful contributions in terms of page views per photo while contributors with strong feelings of challenge and high desire for recognition are negatively influenced.

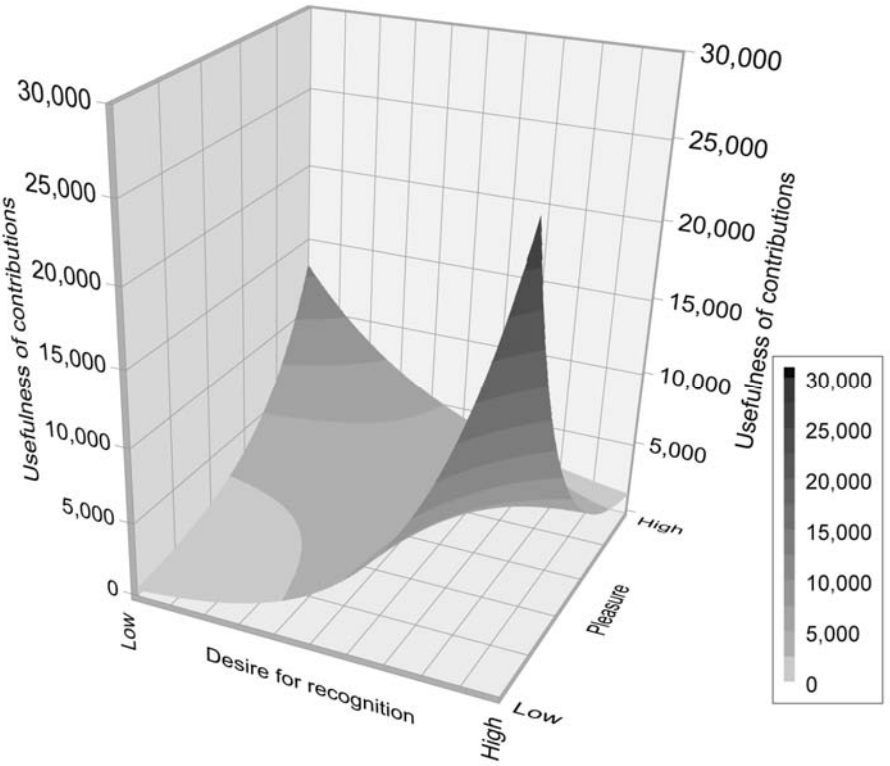

Figure 15 First and higher order effects of desire for recognition and pleasure on usefulness – NU.nl

It appears that our initial assumption that interaction effects only occur when no rewards are provided, is not supported. An adjustment of our Hypotheses 6 may therefore be required.

6.6. Conclusions

6.6.1. Summary of main findings

In our second study we investigated the effects of motivation on participation and performance of 605 members of an online community. In support of our conceptual model, we found that intrinsic motivations drive some performance aspects of online volunteers. The intrinsic motive of pleasure has a positive effect on the quantity of contributions while the intrinsic motive of challenge has a positive effect on the novelty of contributions. As expected, no effects of intrinsic motives on usefulness were found. It appears that

intrinsic motives have fewer effects than expected. No positive effects were found for the relation between challenge and quantity nor for the relation between pleasure and novelty.

The missing positive effect of the motive challenge on quantity can be explained by the occurrence of some routine. It appears that contributors uploading photos of multiple events are planning their attendance at events where they can possibly take some newsworthy photos. The shift towards some level of routine does not affect the pleasure of persons doing the activity; people still enjoy photographing and uploading the photos.

The results of this study indicate that the motive of challenge is more important in driving novel behavior than pleasure. As indicated by Amabile (1993) the production of novel output can have dull moments. For example waiting for the right time to shoot the most magnificent and novel photo may be more of a matter of persistence and challenge than pleasure. People seeking to enjoy this activity may not be able to stand these dull moments and do not come to novel output while people that have high challenge motivations are eager to get that final photo shoot. Following Amabile's reasoning of dull moments in novel production, the fact, that the motive of challenge has positive effects on the novelty of contributions while the motive of pleasure does not have this effect, is easily explained.

It should be noted that the contributions to Tweakers.net and NUfoto.nl are different in time consumption: writing a reaction to a news item will take less time than the production of a photo taken at a planned event. We argue that less time spent also reduces the chances of dull moments which explains the difference in effects of the motive of pleasure found in the two studies.

More important are our findings on the effects of extrinsic motives in the presence of rewards. Since NUfoto.nl provides financial and reputational rewards, we expected positive effects of extrinsic motivations on performance. We argued that these effects are conditional to the relatedness of reward criteria: when reward criteria are in line with the performance measure, a positive effect can be expected. This was indeed found since contributors with high desire for compensation provided a larger number of contributions therewith positively influencing the chance to sell the photo to external parties. Persons with a high desire for recognition provided more useful contributions, which was the basis for receiving reputation rewards. No effects were found for rewards that have reward criteria unrelated to performance.

We did not expect any interaction effects of intrinsic and extrinsic motivations since contributors of NUfoto.nl are offered financial and reputation rewards. To our surprise, we

found two robust interaction effects, namely the interaction effects of desire for recognition and pleasure on quantity and usefulness. Both interactions have a negative coefficient indicating that people mainly motivated by pleasure provide higher quantities and more useful contributions as compared to people that are highly motivated by both pleasure and the desire for recognition. The meaning of these findings is discussed in the following subsection.

Finally we were not able to construct a significant regression model for the relation between motivation and the decision to contribute. Therefore we are not able to identify which intrinsic and/or extrinsic motives drive a registered member's decision to upload photos.

6.6.2. Theoretical implications

Although some articles indicate that intrinsic motivation is not a unitary construct, still the majority of researchers do not treat self-interest and enjoyment as separate determinants of behavior (Reeve, 1989; Lindenberg, 2001). The results of this study suggest that it is not correct to consider intrinsic motivation as a unitary construct. The Tweakers.net study already showed some differences in the size of the effect of the motives of pleasure and challenge, but these differences are larger in this study. The results of NUfoto.nl and Tweakers.net studies are therefore in line with the 'interest-enjoyment distinction in intrinsic motivation' as formulated by Reeve (1989). Reeve hypothesized that two types of intrinsic motivations can be distinguished on the basis of differential determinants. Task interest – which is similarly defined as the intrinsic motive of challenge – arouses the initiation and direction of attention and exploratory behavior, while enjoyment or pleasure sustains the willingness to continue and persist in the activity. The results of the NUfoto.nl study certainly provide empirical evidence for the interest-enjoyment distinction.

In the NUfoto.nl study, we found that the direct effects of rewards are dependent on the reward criteria. If the reward criteria are aligned with the performance measure, then a positive effect occurs. This is not at all striking since it is generally accepted that people seek information concerning which activities are rewarded and then seek to do those activities (Kerr, 1975). Therefore the second finding – no effects of extrinsic motivations occur when a reward is present and reward criteria are not aligned – is more important since this is a more beneficial situation compared to the absence of rewards. The presence of a reward with non-related reward criteria can be considered as a hygiene factor. A hygiene factor has negative effects when it is absent, while it does not have positive effects when it is present.

Aggregating these findings with the findings of the previous study, we can visualize the direct effects of the absence and presence of rewards as in Figure 16.

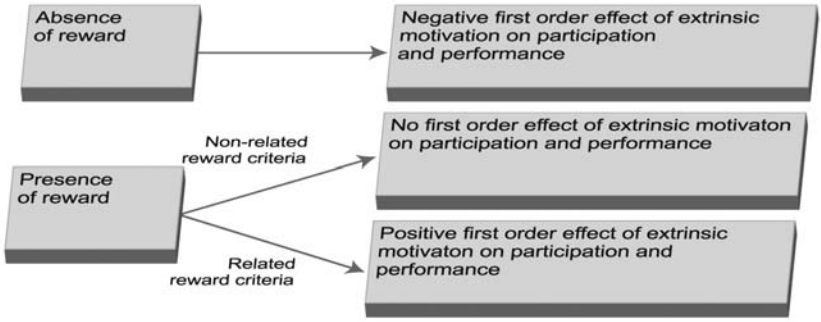

Figure 16 Direct effects of extrinsic motives in absence or presence of rewards considering relevance of reward criteria

With regards to the interplay between intrinsic and extrinsic motivation, we observe some patterns. First we conclude that interaction effects occur in fixed combination. The motive 'desire for compensation' interacts with the motive of challenge while the motive 'desire for recognition' exclusively interacts with the motive of pleasure. Secondly – and in accordance with our hypotheses – we only found negative interaction effects. Finally – and contrary to our hypotheses – we found that interaction effects also occur when rewards are offered. The reason that negative interaction effects occur is that reward criteria are vaguely formulated and vague reward criteria suggest that the reward giver puts a low value on the task (Eisenberger, Pierce and Cameron, 1999). In the NUfoto.nl study, the reward criteria for the financial reward were also vague. Nevertheless no interaction effects for the motive, desire for compensation, and intrinsic motivations were found. We argue that financial rewards convince people of the relevance for the task/reward giver through its tangible nature and therefore, in the presence of financial rewards, no negative interaction effects occur. Through its intangible nature, recognition rewards do not provide objective information on how the reward giver values the execution of the task. When combined with vague criteria, people are not convinced that the reward giver values the task. As a consequence, interaction effects of intrinsic and extrinsic motivation occur in the presence of a reputation reward combined with vague reward criteria.

The interaction effects are summarized in the Figure 17.

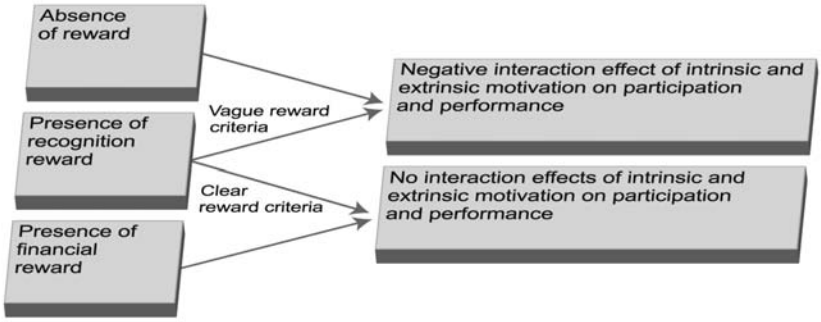

Figure 17 Interaction effects of extrinsic motives in absence or presence of rewards, considering clearness of reward criteria

6.6.3. Managerial implications

This study shows that the intrinsic motive of pleasure is an important denominator of performance aspects that require persistence, such as delivering large quantities. The intrinsic motive of challenge is more important for the provision of novel contributions. We indicated before that firms can not increase the intrinsic motivation of their online volunteers, but can influence the participation of people with the right motivation profile through communication. This means that when the execution of the activity requires persistence, the crowdsourcing firm should emphasize in its communication how much fun volunteers experience when doing the crowdsourced activity. NUfoto.nl may publish stories in which contributors enthusiastically tell how much they enjoyed photographing each news item that came into their lives. When the crowdsourcing firm aims to stimulate novel contributions, the message has to be different. The message then must highlight how much a person developed his or her photographing skills by trying new techniques and new perspectives.

This study also shows that rewards meant to improve certain performance aspects, also have a positive side effect on other performance aspects that are not addressed by the reward criteria. This side effect may provide an extra argument for crowdsourcing firms issuing rewards to their contributors.

Finally the results of this study indicate the importance of the clearness of reward criteria. In particular the reward criteria for recognition rewards should be formulated very clearly. If not, people with high intrinsic and extrinsic motivation will show undesired behavior, namely lower performance. Therefore the effectiveness of recognition rewards is influenced by the clearness of the reward criteria.

6.6.4. Limitations and directions for future research

When comparing the effects of intrinsic motivation in the Tweakers.net and NUfoto.nl studies, we can conclude that although intrinsic motivation is an important driver for the performance of volunteers, we also noted some differences in the effects of the motives, pleasure and challenge. In the Tweakers.net study both pleasure and challenge showed significant effects on performance, while in the NUfoto.nl study pleasure appears to have a positive effect on quantity and challenge a positive effect on novelty. We argue that the nature of the crowdsourcing activities differ in the time spent: Tweakers.net requires spending less time on a single contribution (writing a reaction to a news item) than the NUfoto.nl contributors who must plan, produce and upload a news photo. We expect that the more time spent would decrease the pleasure that a contributor has and the motive of challenge will become more important to finish the activity. These expectations should be tested in an experiment in which participants have to execute a similar activity and have identical rewards offered, but the duration of the activity differs.

Based on the results of the NUfoto.nl study, we conclude that the clearness of reward criteria, when financial rewards are offered, does not influence the effects of motivation. It should be noted that in the NUfoto.nl study solely vague criteria are used. Thus, no comparison with a context in which clear criteria for receiving a financial reward can be made. It may be argued that vague and clear criteria influence the effect's size. This would mean that when clear criteria for receiving financial rewards are used, the desire for compensation has stronger positive effects on performance because the contributor is even more convinced of the importance of executing the task. Such a moderating effect of reward criteria can be checked in experiments in which similar activities have to be done and also similar rewards are offered, but the reward criteria differ in clarity.

In the NUfoto.nl study we were not able to test the effects of different sizes of financial rewards, e.g. different prize amounts. Therefore we can not conclude whether small and large financial rewards have similar or different effects. Therefore experiments with different prize amounts are recommended for future research.

Chapter 7. Case 3: Green Challenge

7.1. Introduction

The third case addresses the Green Challenge, an international contest for eco-friendly innovations. The Green Challenge can also be characterized as a crowdsourcing initiative since the contest is open for all persons around the world and its promotion is through viral marketing. At the same time there are two substantial differences with the two previous studies. First, the rewarding system includes an extreme money-prize, namely € 500,000 for the winner. Second, contributions in this case are far more substantial since participants have to develop and upload a high level business plan consisting of 5 to 11 pages of text. This contribution can be qualified as a R&D activity which requires more time and energy than the provision of user generated content such as the reaction to the Tweakers.net fora or the uploading of newsphotos at the NUfoto.nl website.

Innovation contests such as the Green Challenge fit well with the current vision that open innovation provides new mechanisms for organizing R&D. Following the view of Bill Joy, the co-founder of Sun Microsystems,

> ***"No matter whom you are, most of the smartest people work for someone else",*** *crowdsourcing provides a mechanism for tapping into a global knowledge and talent pool outside the company.*

It should be noted that innovation contests with big-money prizes are not new, but have existed for centuries. In 1714 the British parliament passed the Longitude Act in which GBP 20,000 was offered for a method to determine a ship's longitude. This contest was successful as it resulted in the invention of the chronometer by John Harrisson (Sobel, 1995). It has repeatedly been shown that innovation contests with big money prizes induce innovations that otherwise would not have been developed (Kremer, 2000; Kremer and Zwane, 2002; Masters, 2003).

Multiple researchers have investigated the effects of big-money prizes in contests. These researchers conclude that an increase of the prize amount also increases the number of participants in the contest (Brunt, Lerner and Nicholas, 2008; Yang, 2009). In addition, the differences between the provisioning of a single prize (the so called 'winner-takes-all' prize design) versus multiple prizes consisting of lower amounts are studied. It appears that

multiple prizes elicit higher entry rates because it encourages more entry among low ability contestants (Cason et al, 2010). The study of Cason and co-researchers describes an experiment in which prizes vary from USD 0.40 up to USD 20. These amounts are not comparable with the money prize offered in the Green Challenge contest.

Research on innovation contests mainly focuses on the economic effects of prize design (Davis and Davis, 2004). To our knowledge, no research is available on the effects of prize design, and in particular big-money prizes on the motivation and behavior of individual participants. Psychologists suggest that the size of the reward does indeed influence motivation and behavior (e.g. Eisenberger and Selbst, 1994), but their conclusions are based on the comparison of small rewards (e.g. 50 cents) with somewhat bigger rewards (e.g. some dollars). We argue that big-money rewards have more dramatic effects on motivation and behavior. Our hypotheses on the effects of motivation in the presence of rewards, which are valid for the previous studies, may therefore not apply to the context of this study. In the first instance we expect that in a context of extreme money rewards, the effects of extrinsic motivation on performance will be much stronger than the effects of intrinsic motivation. Since no scientific literature on this topic exists, we designed this study as an explorative case study in which we describe the rewards and their criteria, motivations and behavior of participants and explore the relations between these.

7.2. Green Challenge contest design

7.2.1. Objective of the Green Challenge contest

The Green Challenge was organized by the Dutch Postcode Lottery, an organization raising funds for charities in the Netherlands and abroad. Sustainability is an important issue for the Dutch Postcode Lottery and hosting a contest for green innovations fit well with its mission. The start of the Green Challenge followed a visit of Bill Clinton to the Lottery in the Netherlands in December 2006 in which Clinton stated that:

> *"The fundamental problem is an entrepreneurial, disorganized, undercapitalized opportunity competing against a highly organized, overcapitalized, old-energy economy that has still many, many people in its grip."* [36]

[36] http://www.greenchallenge.info/web/show/id=68093

The Head of the Charity Department of the Postcode Lottery believed that the Green Challenge could help to generate the new type of solutions Clinton was talking about. The Lottery was convinced that the world has enough creative, entrepreneurial people in it to make that crucial difference that will change the world and believed that great ideas come from the most unexpected places. They started the contest in 2007 using the slogan "climate change is a challenge; there is no more time to waste". Participation in the Green Challenge is open for every adult person having ideas for an innovative product or service that fits an eco-friendly lifestyle, directly reduces greenhouse gas emissions and scores high on convenience, quality and design.

The Green Challenge is promoted via viral marketing. Viral marketing appears to be successful because the participants are quite geographically distributed. Although almost one third of the participants of the 2008 challenge originated from the Netherlands (29%), more than half of the participants came from countries outside Europe. Remarkable are the large number of participants from India (25%).

Table 12 Region of origin participants Green Challenge 2008

Region	Number of participants	Percentage
Europe	96	43%
Asia	67	30%
America	43	19%
Africa	12	5%
Mid East	5	2%
Australia	2	1%
Total	*225*	

The first challenge was organized in 2007. In the first year 439 ideas were gathered, in the second year 235 ideas.

In 2007 and 2008, the Dutch Postcode Lottery donated a total of €1.1 million to three winners to help them turn their ideas into real products. In 2007, a Dutch inventor won with a product to help people generate their own electricity. In 2008, the prize was granted to an American inventor team offering sustainable ecological alternatives to conventional synthetic building materials. An additional prize was granted to the inventors of easy-to-use consumer solar panels.

This study focuses on the participants of the Green Challenge 2008 and their contributions.

7.2.2. Contest procedure

Participants of the Green Challenge have to submit high level business plans, including a marketing and financial plan, using a fixed-format electronic form. A pre-jury assesses all submissions using three criteria: entrepreneurship, creativity and sustainability. This pre-jury selects four to five finalists. Finalists have to defend their business plans to the public during the PICNIC cross media week, an international conference for media and creative industry visited by about 7,000 people. After the presentations a final jury, consisting of famous business executives, such as Sir Richard Branson, decides on the best submission. The prizes are awarded during the PICNIC conference.

7.2.3. Rewards

The winner receives € 500,000 to realize his/her business proposal. Besides this big financial reward for the winner, all finalists have the benefits of publicity which improves a person's reputation and network. Non-finalists do not receive any rewards.

Participants of the contest appreciate not only the financial reward, but also the recognition rewards very much. This is illustrated by the citations of the winner of 2007 contest:

> *"It felt like I was in the Champions League with my Qbox [productname]. The people present at PICNIC are all very fascinating in their own fields. And on top of all that, Sir Richard Branson was announcing the winner! I had always wanted to meet Sir Branson; he's such a renowned businessman. I've read many of his books. At the Green Challenge, I thought that I just wanted to high-five Sir Branson and then I could die, in a manner of speaking. When I won, I got the prize from his hand and also the opportunity to high-five him! I felt privileged, and I was."*
>
> *"I'm now able to do three to five pilot experiments and cooperate with different parties. It's important that people get to see the look and feel of the Qbox. We have to give them an example of what it can do. The Green Challenge made this possible, but also you mustn't underestimate the publicity the Challenge provides. That's priceless! I've had international companies and private individuals call me about the Qbox."*[37]

[37] http://www.greenchallenge.info/web/show/id=68422

7.2.4. Reward criteria

In the previous studies, we concluded that the relatedness of reward criteria is a relevant condition for the direct effects of extrinsic motives on performance. At its website, the Green Challenge organization emphasizes that it is searching for inventions: *"Keep your mind and your imagination open, and dare to dream up something new that we can add to this list next year. Surprise us!"*[38] Therefore it is clear that one of the reward criteria is novel performance. The entry criteria and the game rules state that entries are evaluated on the following criteria[39]:

> *"The entry should have the potential to reduce greenhouse-gas emissions by an amount you can roughly estimate;*
>
> *The entry should be developed enough to execute; and*
>
> *The entry should be realizable as a usable product or service within the next two years*."

So the organization makes clear that usefulness and sustainability are also reward criteria.

7.2.5. Research challenge

Although the organizers of the Green Challenge are very satisfied with the ideas presented by the finalists, they also expressed their disappointment on the quality of the majority of the submissions. Despite the significant reward and the clearly communicated selection criteria, only 25% of the submissions met expectations. The organization expressed that the time and energy needed to filter out submissions meeting expectations for inclusion in the long-list, was very high since all members of the pre-jury had to assess all submissions. Therefore it would be helpful for the organizers of the Green Challenge to discourage participants that did not meet the expected performance.

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[38] http://www.greenchallenge.info/web/show/id=68237

[39] http://www.greenchallenge.info/web/show/id=68083, http://www.greenchallenge.info/web/show/id=68160

7.3. Case specific methodology Green Challenge

In this study we again collected the data from different sources: archival data gathered at the Dutch Postcode Lottery and a websurvey among the participants of the Green Challenge 2008. The websurvey provided information on the individual motivation levels of participants. Performance data of the participants was not available since the pre-jury of the Green Challenge did not score all individual entries on all three selection criteria. The pre-jury only put together a long list and short list of the best entries. Therefore, we asked an expert jury to assess the entries of respondents of the websurvey and provide scores on each entry. Dutch Postcode Lottery provided us with the entries of respondents under the condition of confidentiality.

7.3.1. Contributions versus participants

The vast majority of participants issued one idea. More detailed analysis of the participants with multiple entries showed that there were several double counts of the same idea. Out of 225 unique participants only 5 participants issued 2 instead of 1 idea of which only one responded to our websurvey. These low numbers did not form a sufficient base for reliable statistical analysis.

7.3.2. Websurvey

Questionnaire

For the measurement of motivation we used the Work Preference Inventory (Ambile et al, 1994). The statements were adjusted in such way that they related to the issuing of high level business plans for innovative and sustainable products or services. The Green Challenge context required an additional motive than the ones taken into account in the WPI. We added a third intrinsic motive 'social responsibility' (for a detailed description see paragraph 7.4.4).

In this study, an English questionnaire was used since the majority of the participants (71%) lived outside the Netherlands. The official language on the Green Challenge website was also English. For the complete survey see Annex D.

Websurvey procedure

An invitation to fill in the websurvey was sent to the 225 participants of the Green Challenge. Please note that a few participants issued more than one idea to the Green Challenge 2008. This explains the small difference between the number of ideas and the number of participants. After one week a reminder was sent to the non-respondents. To avoid a bias of people that are highly intrinsic motivated, we sent out a second reminder

to non-respondents in which we offered a book upon completion of the websurvey. We offered respondents the choice between two popular books on the subject sustainability (Hot, Flat and Crowded by Thomas Friedman or Cradle to Cradle by Michael Braungart and William McDonough). Considering that sustainability is one of the main focal points in the Green Challenge, we expected that this reward would be attractive for its participants. For the sake of fairness, we also gave the respondents of the non-rewarded group the – for them unexpected – reward.

In total, 104 participants (46%) started the websurvey and 86 participants (38%) completed the survey. From the persons that completed the websurvey, 67 persons (78%) belonged to the non-explicitly rewarded group and 19 participants (22%) to the explicitly rewarded group. It appeared that the completion-contingent reward had a positive effect on response: the drop-off percentage in the explicitly rewarded group (5%) is substantially lower than in the non-explicitly rewarded group (20%).

We eliminated the data of 2 respondents for who we did not have a complete business plan due to technical problems in saving their digital submission. The reason for eliminating these two respondents is that incomplete business cases could result in incomplete scores on the performance measures. As a result, the data of 84 participants was used in all subsequent analysis.

Despite the highly satisfactory response rate, there is a possibility of non-response bias. Therefore we checked if the means of the control variables of all participants (also including non-respondents) significantly differed with the means of the respondents. Independent sample t-tests did not show significant differences in age, gender and country of residence between all participants and respondents. The significance levels of the two-tailed t-test were all well above 0.10.

We expected that the non-rewarded respondents show higher intrinsic motivation and lower extrinsic motivation than rewarded respondents. We checked this in an independent t-test. It appeared that respondents of the rewarded and non-rewarded group did not significantly differ ($p > 0.30$) in their scores of individual intrinsic and extrinsic motives.

7.3.3. Expert jury

The expert jury consisted of a selection of three pre-jury members of the Green Challenge 2008. A jury consisting of three members is considered to be of an acceptable size (Piller et al, 2006; Amabile, 1996). We selected the pre-jury to represent a variety of knowledge and

expertise. As a result, our expert jury had knowledge and experience in the assessment of business plans, innovative and sustainable products and services and new technologies. Knowledge and experience with the domain in question is considered to be essential for expert juries (Amabile, 1982).

Since rewards improve the accuracy of jury members significantly (Sniezek et al, 2004), the jury members were paid for their work. Each member received a fee of € 1000 for about 2.5 days work. Members were individually instructed on criteria and scales that had to be used in the assessment and used the same score template. Judges provided their ratings individually, without consulting other judges, within a two week period. They rated the criteria usefulness, sustainability and novelty. The list of criteria as provided to the expert jury is included in Annex E.

After the rating of the expert jury interjudge reliability of each criterion was analyzed. The ICC for usefulness was 0.93, for sustainability 0.78 and for novelty 0.93. Since ICC values above 0.7 indicate a high degree of consensus (Piller et al, 2006) and all lower bounds of 95% confidence intervals were above 0.70, the level of agreement between the judges was acceptable.

7.4. Measurement of variables

7.4.1. Usefulness of contributions

Ideas are considered useful if they have the potential for direct or indirect value to the organization, in either the short or long term (Amabile, 1996; Shalley et al, 2004). The organization of the Green Challenge used two criteria that are in line with this definition of usefulness: executability and realisability. Executability is understood as the completeness, concreteness and realism of the business plan. Realisability is described as the likelihood that a usable product or service can be offered within the next two years.

In this study, usefulness is considered as a formative construct composed of the four criteria completeness, concreteness, realism and realisability of the plans within two years. We added a criterion in which we explicitly asked how useful the submission was for the Green Challenge organization. Each criterion was rated on a three or five point scale. Before calculating the unweigthed average, the three point scales were converted in a five point scale.

7.4.2. Sustainability of contributions

Sustainability is included as a separate criterion since it was clearly announced on the Green Challenge website that reduction of greenhouse-gas emissions was a main criterion for winning the challenge.

Multiple definitions of sustainability exist (e.g. WCED, 1987; Serageldin, 1996). These definitions, however, all highlight a need to resolve environmental degradation in order to leave future generations as many opportunities as we have ourselves. These definitions do not provide any guidance on what resolving environmental degradation exactly means (Pasqual and Souto, 2003; Epstein and Roy, 2001). Multiple indicators are developed that measure different aspects of sustainable or environmentally friendly production, ranging from the measurement of energy and water usage, percentage waste and global warming potential (e.g. Veleva and Ellenbecker, 2001). Considering that the Green Challenge focuses on a reduction of global warming [40] and explicitly asks participants to calculate the reduction of greenhouse-gas emissions realized through their innovation, we asked the jury to assess how convincing and concrete the greenhouse-gas reductions described in the entries were. The unweighted average of the ratings, in terms of the believability and concreteness of the greenhouse gas reduction description and calculation, formed the sustainability measure.

7.4.3. Novelty of contributions

Novel ideas are defined as unique ideas relative to other ideas currently available in the organization (Shalley et al, 2004). Litchfield (2008) distinguish low and high levels of novelty: low levels of novelty are incremental innovations and high levels of novelty are radical innovations. According to Ali (2000) the novelty of a product or service can be based on a comparison with available products: is it a me-too product versus a breakthrough product that creates new industries or markets? Following these definitions we developed four criteria for the assessment of novelty:

- the level of innovation (no innovation – incremental innovation – radical innovation);
- the technical newness of the product or service;
- the newness of the product or service for the customer;
- the newness of the product or service in the market for sustainability products and services.

Our measure of novelty is the unweigthed average of the scores for these criteria.

[40] http://www.greenchallenge.info/web/show/id=79019

7.4.4. Motives

Lindenberg (2001) argued that in addition to enjoyment and challenge, also another type of intrinsic motivation exists: the feeling that one must behave according to a particular rule, norm or principle. Lindenberg termed it as obligation-based motivation. Other authors acknowledge that values, related to altruistic and humanitarian concerns for others, motivate people in voluntary behavior in which they help others (e.g. Clary et al, 1998). The relevance of norms and values driving voluntary behavior is also considered to be relevant for the behavior of open source or online community members. These community members aim to help others by documenting their knowledge in Wikipedia (Nov, 2007), give legal advice to unfortunate people (Franke and Shah, 2003) or to provide software code in open source communities (Markus et al, 2000; Stewart and Gosain, 2006; Hars and Ou, 2002). The contributions of those community members are explicitly meant to increase the welfare of other people, for example by giving access to knowledge and tools that people do not have or can not develop themselves.

In this study we observe that organizers explicitly appeal to people's feelings of concerns and responsibility for an eco-friendly environment. This can be concluded from the introductory text on the Green Challenge's website: "Climate change is a challenge. There is no more time to waste. The world must embrace a new, greener lifestyle. One bright idea can make a big difference"[41]. This introductory text is followed by a request to submit ideas for the contest. By emphasizing the urgency of the problem and indicating that individual actions really can help, the Green Challenge organization relies on individual feelings of responsibility in solving climate change problems. Therefore obligation-based motivation is also measured in this study.

The measurement of obligation-based motivation is based on the Values scale of the Volunteer Functions Inventory (Clary et al, 1998) and adjusted to the context of this study. The original statement "I feel it is important to help others" is, for example, adjusted to "I feel it is important to provide solutions to climate change when participating in the Green Challenge contest".

[41] http://www.greenchallenge.info/web/show/id=68108

7.4.5. Control variables

The Green Challenge organization provided us with data on demographic characteristics such as gender, age and country of residence of all participants in the Green Challenge 2008. These data serve as control variables in this study.

The information on country of residence and nationality was clustered in two groups: western country versus non-western country. African and Asian countries are considered non-western countries; all other countries are considered western countries.

7.4.6. Validity

Prior to exploring the relations between motivations and performance, we conducted a confirmatory factor analysis to examine the distinctiveness of the motive related measures used in this study. The initial estimated confirmatory factor model showed model fit statistics below acceptable levels
(χ^2=670.89 [424, n=86]; p<0.01; RMSEA=0.10; CFI=0.56; SRMR=0.15). It appeared that the sample size was smaller than the number of model parameters and therefore parameter estimates were unreliable. In order to construct a model with a lower number of model parameters, we had to delete a number of items. We selected those items that caused cross loadings. The adjusted CFA model showed a sufficient fit
(χ^2=32.34 [25, n=86]; p=0.15; RMSEA=0.07; CFI=0.95; SRMR=0.07).

For completeness, we compared this higher-order five-factor model structure to four-, three- and two-factor structures. In the four-factor model, the intrinsic motives of pleasure and challenge are taken together in one factor. In the three-factor model, the intrinsic motives of pleasure, challenge and social responsibility are taken together as one factor comprising intrinsic motivation. Finally the two-factor model combines the two extrinsic motives into one factor. Runs of these models showed that the Expected Cross Validation Index (ECVI) values increased compared to the higher order, five factor model. Lower order factor models show smaller values for the Consistent Akaike's Information Criterion (CAIC) which indicate a better model fit. It should be noted that the CAIC is sensitive for size which is in this study substantially smaller compared to the other two studies. Therefore we also added the AIC, a fit statistic which is not sensitive for sample size. The AIC is optimal for the five-factor model which provides support for the selection of this model (Diamontopoulos and Siguas, 2000).

Since the composite reliability of each factor from our final CFA model is greater than 0.60, the items provide reliable measurement of each factor (Diamontopoulos and Siguas, 2000).

The values of average variance extracted are larger than 0.50. So a substantially higher amount of variance in the items is captured by the factor compared to that accounted for by the measurement error (Diamontopoulos and Siguas, 2000).

7.5. Regression analysis models

The unweighted average ratings per variable were normally distributed so we could use linear regression in this study.

In all regression analyses, we followed a stepwise approach. Considering the small number of respondents (N=84) and the increase in the number of motivation variables and interaction effects, we increased the number of steps. In the first step, the three control variables (gender, age, country) were included. In the second step, we added the intrinsic motivation variables and in the third step, the extrinsic motivation variables. In the following steps we included blocks of interaction effects: a block with interaction effects of pleasure and extrinsic motivation, followed by interaction effects of challenge and extrinsic motivation and finally the interaction effects of social responsibility and extrinsic motivation.

7.6. Results quantitative analysis

Table 13 lists the means, standard deviations and correlations for the variables.

Table 13 Descriptive statistics and correlations – Green Challenge

Variable	N	Mean	s.d.	1	2	3	4a	5 a	6	7	8	9	10	11
1. Usefulness	84	2.42	0.84											
2. Sustainability	84	1.35	0.36	0.62**										
3. Novelty	84	2.23	0.90	0.67**	0.54**									
4. Gendera	84			-0.21	-0.08	-0.05								
5. Countrya	84			-0.11	0.01	-0.03	0.16							
6. Age	84	41	12.7	.013	0.16	0.08	0.16	-0.29**						
7. Pleasure	84	3.57	1.03	-0.23*	-0.26*	-0.32**	0.03	-0.11	0.02					
8. Challenge	84	4.71	0.98	-0.11	-0.07	-0.07	0.07	-0.18	-0.03	0.47**				
9. Social responsibility	84	2.89	0.52	-0.10	-0.15	-0.27*	0.08	0.00	-0.02	0.63**	0.42**			
10. Compensation	84	3.5	0.87	0.02	0.06	0.14	-0.04	-0.06	0.15	0.31**	0.22*	0.21		
11. Recognition	84	3.57	0.76	0.07	-0.06	-0.03	-0.03	-0.02	0.11	0.34**	0.32**	0.44**	.56**	

[a] For categorical data Spearman instead of Pearson correlations are shown

4. Gender dummy coded: 1 = male, 2 = female

5. Continent dummy coded: 1 = America, Europe or Australia (western countries), 2 = Asia or Africa (non-western countries)

*p<0.05

** p<0.01

Two-tailed *t*-tests

Respondents have an average age of 41 years. The majority are male (87%), a sufficient response from female members (11 female respondents, 13% of total respondents) allowed us to include gender as a reliable control variable. The majority of respondents (75%) live in Western countries (US, Europe or Australia).

The intrinsic motives were highly correlated, especially pleasure and social responsibility ($r=0.63$, $p<0.01$). The same is true for the extrinsic motives ($r=0.56$, $p<0.01$). The intrinsic and extrinsic motives are significantly and positively correlated with the sole exception of social responsibility and the desire for compensation which are not significantly correlated. The control variables are not significantly correlated with the intrinsic or extrinsic motives. Unstandardized means and standard deviations for the intrinsic and extrinsic motives are listed in Table 13. Standardized variables were used in all regression analyses to overcome multicollinearity (Aiken and West, 1991). Through standardization of the motives, the maximum variance inflation factors (VIFs) obtained in the models did not exceed 2.0 and thus they were substantially below the cutoff value of 10 for regression models (Field, 2005).

We report the results of the linear regression models in Table 14, Table 15 and Table 16. Based on the significance of ΔR^2 we conclude that model 4a – which includes control variables, intrinsic and extrinsic motivation and interaction effects for pleasure and extrinsic motivation – is the optimal model for the dependent variable usefulness. Model 3 – which includes control variables and intrinsic and extrinsic motivations is the optimal model for novelty. None of the models testing the relation between the independent variables and sustainability is significant.

Table 14 Results linear regression usefulness – Green Challenge

	Model 1	Model 2	Model 3	Model 4a	Model 4b	Model 4c
Constant	3.14** (0.62)	3.21** (0.62)	3.18** (0.62)	3.51** (0.62)	3.33** (0.62)	3.23** (0.63)
Gender	-0.54* (0.27)	-0.51† (0.28)	-0.52† (0.28)	-0.52† (0.27)	-0.44 (0.28)	-0.48† (0.28)
Country	-0.10 (0.22)	-0.18 (0.22)	-0.14 (0.23)	-0.28 (0.23)	-0.33 (0.24)	-0.24 (0.24)
Age	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)
Pleasure		-0.23† (0.12)	-0.22† (0.13)	-0.22† (0.13)	-0.26* (0.12)	-0.24† (0.13)
Challenge		-0.03 (0.11)	-0.03 (0.11)	-0.10 (0.11)	-0.11 (0.12)	-0.06 (0.11)
Social responsibility		0.08 (0.12)	0.08 (0.13)	0.06 (0.12)	0.05 (0.13)	0.06 (0.13)
Desire for compensation			-0.01 (0.11)	-0.08 (0.12)	0.03 (0.12)	-0.03 (0.12)
Desire for recognition			0.13 (0.12)	0.13 (0.12)	0.13 (0.12)	0.15 (0.12)
*Pleasure * Desire for compensation*				-0.23* (0.11)		
*Pleasure * Desire for recognition*				0.05 (0.11)		
*Challenge * Desire for compensation*					-0.15 (0.11)	
*Challenge * Desire for recognition*					-0.01 (0.12)	
*Social responsibility * Desire for compensation*						-0.09 (0.11)
*Social responsibility * Desire for recognition*						0.07 (0.12)
R^2	0.07	0.13	0.14	0.20†	0.18	0.15
ΔR^2	0.07	0.05	0.01	0.06†	0.04	0.01

† $p < 0.10$
* $p<0.05$
** $p<0.01$

Table 15 Results linear regression sustainability – Green Challenge

	Model 1	Model 2	Model 3	Model 4a	Model 4b	Model 4c
Constant	1.16** (0.28)	1.17** (0.27)	1.17** (0.41)	1.24** (0.28)	1.18* (0.28)	1.16** (0.28)
Gender	-0.06 (0.12)	-0.05 (0.12)	-0.04 (0.12)	-0.04 (0.12)	-0.03 (0.13)	-0.03 (0.12)
Country	0.08 (0.10)	0.05 (0.10)	0.04 (0.10)	0.02 (0.10)	0.02 (0.11)	0.02 (0.10)
Age	0.01 (0.00)	0.01 (0.00)	0.01 (0.00)	0.01 (0.00)	0.01 (0.00)	0.01 (0.00)
Pleasure		-0.10† (0.05)	-0.12* (0.06)	-0.10† (0.05)	-0.12* (0.06)	-0.12 (0.06)
Challenge		0.03 (0.05)	0.03 (0.05)	0.01 (0.05)	0.01 (0.06)	0.02 (0.05)
Social responsibility		0.01 (0.06)	0.01 (0.06)	-0.02 (0.06)	0.02 (0.06)	0.03 (0.06)
Desire for compensation			0.06 (0.05)	0.04 (0.05)	0.06 (0.05)	0.04 (0.05)
Desire for recognition			-0.04 (0.05)	-0.03 (0.05)	-0.04 (0.05)	-0.03 (0.06)
*Pleasure * Desire for compensation*				-0.08 (0.05)		
*Pleasure * Desire for recognition*				0.03 (0.05)		
*Challenge * Desire for compensation*					-0.03 (0.05)	
*Challenge * Desire for recognition*					-0.00 (0.06)	
*Social responsibility * Desire for compensation*						-0.05 (0.05)
*Social responsibility * Desire for recognition*						-0.04 (0.05)
R2	0.03	0.10	0.11	0.15	0.12	0.13
Δ R2	0.03	0.06	0.02	0.04	0.01	0.02

† $p < 0.10$
* $p < 0.05$
** $p < 0.01$

Table 16 Results linear regression novelty – Green Challenge

	Model 1	Model 2	Model 3	Model 4a	Model 4b	Model 4c
Constant	2.16** (0.68)	2.15** (0.66)	2.19** (0.66)	2.26** (0.67)	2.27** (0.66)	2.16** (0.65)
Gender	-0.21 (0.30)	-0.17 (0.29)	-0.12 (0.29)	-0.11 (0.29)	-0.06 (0.29)	-0.08 (0.29)
Country	0.12 (0.25)	0.06 (0.24)	0.05 (0.24)	-0.01 (0.24)	-0.10 (0.25)	-0.06 (0.24)
Age	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)
Pleasure		-0.24† (0.13)	-0.30* (0.13)	-0.27* (0.13)	-0.32* (0.13)	-0.30* (0.13)
Challenge		0.11 (0.11)	0.09 (0.11)	0.07 (0.12)	0.03 (0.12)	0.06 (0.12)
Social responsibility		0.11 (0.13)	-0.11 (0.13)	-0.10 (0.13)	-0.11 (0.13)	-0.01 (0.13)
Desire for compensation			0.24* (0.12)	0.19 (0.12)	0.21† (0.12)	0.18 (0.12)
Desire for recognition			-0.04 (0.13)	-0.02 (0.13)	-0.03 (0.13)	-0.00 (0.13)
*Pleasure * Desire for compensation*				-0.16 (0.12)		
*Pleasure * Desire for recognition*				0.10 (0.11)		
*Challenge * Desire for compensation*					-0.18 (0.12)	
*Challenge * Desire for recognition*					0.04 (0.14)	
*Social responsibility * Desire for compensation*						-0.19 (0.11)
*Social responsibility * Desire for recognition*						0.14 (0.12)
R2	0.02	0.12†	0.17†	0.19	0.21*	0.20†
Δ R2	0.02	0.10*	0.06†	0.02	0.04	0.03

† p<0.10
* p <0.05
** p <0.01

Effects of control variables

As seen in Table 14, gender has a negative coefficient for usefulness (β=-0.52, p<0.10). This means that, ceteris paribus, female community members provide less usefulness contributions than males. No other significant coefficients of control variables on the performance measures were found.

Effects of intrinsic motivations

The intrinsic motive of pleasure shows negative significant coefficients for usefulness and novelty (β=-0.22, $p<0.10$, and β=-0.30, $p<0.05$ respectively), but does not have a significant effect on sustainability. Social responsibility and challenge do not have significant coefficients with usefulness, sustainability and novelty.

Effects of extrinsic motivations

This study shows that the desire for compensation has a significant positive coefficient on novelty (β=0.24, $p<0.05$). The desire for compensation does not have a significant positive effect on other performance measures. The desire for recognition also has no significant effects on the performance measures.

Interplay between intrinsic and extrinsic motivations

In our analysis we found a robust negative interaction effect for pleasure and the desire for compensation on usefulness (β=0.23, $p<0.05$). Other interaction effects were not found.

In Figure 18, the first and higher order effects of pleasure and the desire for compensation on usefulness are plotted. The figures follow the form: $P(Y_i)=c+ß_1x_i+ß_2z_i+ß_3x_iz_i$ (Aiken and West, 1991). From Figure 18, it can be concluded that contributors with strong feelings of pleasure and a low desire for compensation provide more useful contributions, while contributors with strong feelings of challenge and a high desire for compensation provide less useful contributions.

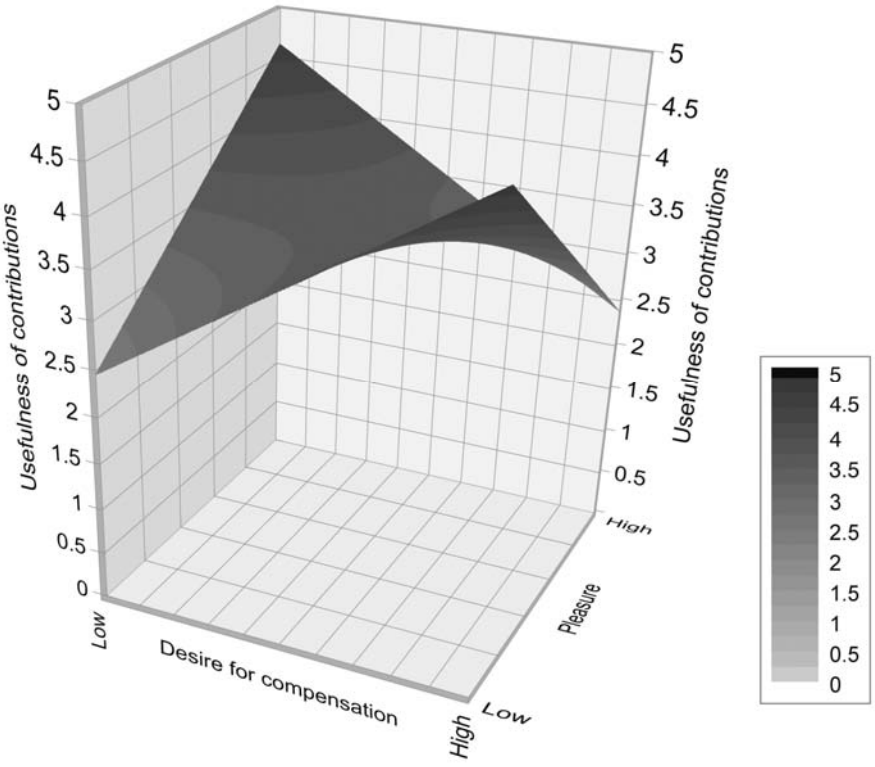

Figure 18 First and higher order effects of desire for compensation and pleasure on usefulness – Green Challenge

7.7. Additional analysis

The Green Challenge results are not in line with the two previous studies with respect to the effects of intrinsic motivation on performance. We did not find a positive effect of Green Challenge participants; on the contrary: some negative effects of intrinsic motivation on performance were found. Namely, pleasure has a negative effect on usefulness and novelty. Since these findings deviate significantly with the findings of previous studies, extra analysis is required.

A possible explanation may be that the motive pleasure is culturally determined. Independent two-tailed tests show that the motive pleasure does not significantly differ for the control variable country of residence: western and non-western participants provided

similar scores for the motive of pleasure. Additional independent two-tailed tests also did not uncover significant differences in the motive of pleasure for male and female participants or young and old participants.

A renewed assessment of the entries showed that not all participants were really seriously competing; see below some answers to the question "What will you do with the prize money if you win the Green Challenge?"

"I will buy a house with swimming pool in a quiet area"
Respondent 51

"Truly speaking: I will use part of the prize to take my mom and dad on a trip around the world"
Respondent 54

"I would take 10% of the prize money to take my wife and family on a nice vacation"
Respondent 43

These participants frankly stated that they would spend the prize money on other things than the implementation of the business plan, while the organization of the Green Challenge explicitly stated in its game rules that "the Prize Money will be used solely for the implementation and/or exploitation of the winning entry or entries and the marketing thereof"[42]. Additionally some answers to the question "Introduce yourself and your qualities and explain why you are the person to successfully realize this idea?" confirm that some people did not seriously participate in the challenge:

"Alternatively I go back to wandering around the country and live in a tent"
Respondent 2

"I always wanted to be a TV star"
Respondent 23

"I did not feel any happiness in my whole life, but I have hope that one day God will see me and will provide me a fortune and happiness in my life"
Respondent 66

[42] http://www.greenchallenge.info/web/show/id=68160

Another aspect which gave an impression of non-serious participation relates to the size of funding required to implement the business plan. Some participants indicated that they require minimal funding: USD 1000 – 5000 (respondent 45) or even USD 50 (respondent 53) and USD 500 (respondent 68). Since the winner receives a substantially higher amount (€0.5 million) inclusion of such minimal funding amounts indicate that submitted ideas are too small for this contest.

The final aspect of non-serious participation is the word count of the entry. The text in some entries was very short so that it was not possible to get a clear impression of the suggested innovation and the plans for implementation. It is obvious that these participants did not spent sufficient effort to be taken seriously.

Based on these observations, we introduced a new variable 'seriousness'. We assessed the entries of all respondents on three aspects of seriousness:

1. *Non-serious plans for spending the prize money or non-serious statements of personal capabilities.*
   Participants that provided weird answers to the questions "What will you do with the prize money if you win the Green Challenge?" and "Introduce yourself and your qualities and explain why you are the person to successfully realize this idea?" are considered to be non-serious.

2. *Too small in terms of required funding.*
   Participants with funding requirements below €300.000 were also considered as non-serious participants.

3. *Word count.*
   The questions raised by the Green Challenge organization included more than 300 words. Based on an assessment of the applications, we concluded that a minimum of 1000 words is required to describe a high level business plan. Therefore we qualified applications with less than 1000 words as non-serious.

It appears that the group of non-serious participants (35 respondents, 42% of total respondents) have significantly different scores for the motive of pleasure as compared with the group of serious participants ($p<0.05$ in two-tailed independent t-tests). The non-serious participants have higher mean scores for pleasure (4.01) than the serious participants (3.45).

It should be noted that the explanatory power of the variable seriousness on performance is significant. We included seriousness as an extra control variable and in linear regression we achieved the following results (see Table 17).

Table 17 Linear regression of control variables and performance measures

	Usefulness	Sustainability	Novelty
Constant	2.17** (0.56)	0.86** (0.27)	1.65* (0.70)
Gender	-0.17 (0.25)	0.04 (0.12)	-0.03 (0.31)
Country	0.23 (0.19)	0.04 (0.10)	0.05 (0.24)
Age	0.01 (0.01)	0.01 (0.01)	0.0 (0.01)
Seriousness	0.91** (0.17)	0.26** (0.08)	0.46* (0.21)
R^2	0.33**	0.15*	0.08†
ΔR^2	0.33**	0.15*	0.08†

† p< 0.10
* p<0.05
** p<0.01

7.8. Conclusions

7.8.1. Summary of main findings

In this study we analyzed the motivation and behavior of 84 participants in the Green Challenge 2008, an innovation contest aimed at stimulating innovations that reduce greenhouse gas emissions. The contest design includes a 'winner-takes-all' financial reward, namely €0.5 million for the winner of the contest. The presence of an extreme monetary reward for the crowdsourcing activity and its effects on motivation and performance of participants was the subject of our analysis.

In this study, we did not formulate hypotheses since we expected that the presence of extreme money rewards would be disruptive; thus, our former hypotheses on the effects of motivation on performance are no longer valid. Therefore this study is meant as an explorative study. We used the same research design for exploring the effects of motivation on performance as we used in the two previous studies.

To our surprise, we found that the motive pleasure had a negative effect on usefulness and novelty. Additional analysis uncovered that two types of participants can be distinguished: non-serious and serious participants. Non-serious participants did not provide convincing answers to questions on how to spend the prize amount and their qualifications for executing the business plan, had minimal funding requirements which did not justify participation in a contest with extreme money rewards or did not provide sufficient text to clearly express their ideas. We showed that the group of non-serious participants performs worse: non-serious participants provide less useful, sustainable and novel contributions. In addition it appeared that the group non-serious participants had significant higher scores for the motive of pleasure.

Thus, serious participants are differently motivated compared to the non-serious participants and the also exhibit different behavior. We argue that the negative effects of pleasure on usefulness and novelty are valid for the group of non-serious participants, but not for the serious participants. Correlation table support this argument by showing significant negative correlations between the motive pleasure and performance for the group of non-serious contributors; these correlations are not significant in the group of serious contributors. Unfortunately, the dataset is too small to split and do the regression analysis separately for the groups of serious and non-serious contributors (less than 50 respondents per group).

A second surprise was on the effects of extrinsic motives on performance in the presence of an extreme money reward and reputation rewards. The reward criteria in the Green Challenge contest were related to the performance aspects of usefulness, sustainability and novelty and were clearly communicated via the website. Despite clear and relavent reward criteria and the enormous money prize, extrinsic motives hardly stimulated performance. The motive desire for compensation only showed a positive relation with the novelty of contributions, the desire for recognition did not have an effect on one of the performance aspects. We argue that the size of the financial reward is so extreme that it overrules the effects of reputation rewards. Participants only focus on getting the financial reward to the point that they neglect the presence of reputation rewards. As a consequence, the motive, desire for recognition, plays no role in this study, i.e. the desire for recognition has no effect on performance.

We observe that the effects of the financial reward is limited to a single performance aspect while the reward criteria indicate that multiple performance aspects are weighted in the evaluation of submitted business plans and the determination of the winner. Based on the results of the Tweakers.net study, we conclude that it is possible for rewards to have effects

on multiple performance aspects. However there are some differences between Tweakers.net and the Green Challenge that may explain why rewards have an effect on one or multiple performance aspects. First, the Green Challenge contest is characterized by a 'the-winner-takes-all' reward structure (e.g. only the winner receives the money prize) while rewards in the Tweakers.net community are in reach for many participants (e.g. Tweakers.net provides a reputation reward to more contributors by publishing lists of top-ten contributors on several performance aspects). Second, the Green Challenge publishes the names of the finalists and the winner and summaries of their ideas. However, they do not provide transparency on how these reward receivers performed on the three evaluation criteria. In the Tweakers.net community, the performance per individual can be traced since in the profile of each Tweaker, the number and usefulness of one's contributions are listed. So performance is not only published but also known for all contributors and not limited to top performers. We argue that publishing the actual performance will extend the effectiveness of rewards. In other words, if the Green Challenge organization explains how winning participants are assessed for the three individual performance criteria, this would extend the effects of the financial reward beyond the main performance criterion 'novelty'; the financial reward will also have an effect on the other performance aspects.

In this study we found a negative coefficient for the interaction of the motives pleasure and desire for compensation on the usefulness of contributions. Due to this interaction effect, the participants that are mainly motivated by pleasure rather than by the desire for compensation provide more useful contributions, while participants that are also strongly motivated by the desire for compensation provide less useful contributions. We suspect that the group of non-serious participants is disturbing our analysis. Since they also showed contrary direct effects (e.g. negative effects of pleasure on performance), one may assume that there are also unexpected interaction effects. We assume that the group of serious participants does not show this interaction effect. Unfortunately, we cannot confirm our argumentation with results of a regression analysis that only include serious participants, since this group is too small.

7.8.2. Theoretical implications

The main caveat of this study is that extreme money prizes have disruptive effects on motivation and behavior. Motivation literature acknowledges that the size of rewards matters when assessing intrinsic motivations and behavior (e.g. Eisenberger and Armeli, 1997; Eisenberger and Selbst, 1994). These authors conclude that a small reward has a detrimental effect on intrinsic motivation and behavior, while large rewards increase intrinsic motivation and behavior. It should be noted that large rewards in these studies of

Eisenberger and colleagues are a few dollars which can not be compared with the prize amount in this study.
In our study we show that an extreme money reward attracts people that are non-serious and do not qualify for the contest. Participation of non-qualified people is not in line with the general argumentation of motivation theorists that when a task requires skills and expertise that are too stretching for an individual, this person will be de-motivated. As a consequence the person will not engage in the task (Amabile, 1993). This study shows that non-qualified participants are not deterred from participating. Other real-life examples support our finding: a variety of contests (also in other domains such as music and dance) must deal with large numbers of non-qualified participants, while it is obvious to outsiders that they do not have any chance to receive a prize. We did not examine whether participants consider themselves a suitable candidate (i.e. do they overestimate or overvalue their own skills) or whether they solely participate because they are seeking fun. In the first case, the argumentation of motivation theories is still valid: people perceive themselves as capable of doing the task although others have different opinions and do not get de-motivated. In the second case, the argumentation, that a person gets de-motivated when a task requires skills and expertise that the person does not have, fails. Pleasure appears to be a disruptive motive that stimulates a non-qualified person to become a contest participant. Note that we were not able to analyze motivations driving the decision to contribute since we could not trace persons initially interested that finally did not participate in the challenge; no information on non-contributors was available in this study.

7.8.3. Managerial implications

Based on this study and other real-life examples, it can be concluded that participation by non-serious people is inevitable. Participation by this group is not necessarily a problem when you can limit the time that you have to spend on non-serious entries and when it does not influence the decision of serious candidates to participate. In this study, we showed that non-serious participants can be quite easily detected on the basis of their answers to three questions: required funding, spending of the prize money and a person's qualifications to execute his/her own business plan. Reading of the answers to these questions takes no more than a few minutes and results in a filtering of serious participants which is about half of the total number of participants. In this way, the evaluation procedure can be made more efficient. Therefore organizers of innovation contests should introduce a small number of easy to assess questions regarding the seriousness of participation.

In addition, we recommend publishing of the performance of winners. This helps future participants to understand how they can meet the desired performance levels. In this way,

the organization can improve the performance of future participants. It can also be beneficial to publish the performance scores of all participants. Each participant receives feedback and bad-performers may be deterred from future participation.

7.8.4. Limitations

In this explorative study it appears that the group of participants in an extreme money contest is not homogeneous. Our argumentation that a separate group of participants, which are mainly motivated by pleasure in their decision to participate, can be distinguished by quantitative research of motivations and the decision to participate. Additional research is also required to test our hypothesis that this group shows different behavior than the group of serious participants. It is important that the number of datasets is large enough to facilitate the analysis of a separate group of participants, i.e. split the datasets.

To our knowledge, research on the effects of extreme money rewards on motivation and behavior is missing. Therefore we recommend a single study of an innovation contest with a big money prize, a smaller money prize and no money prizes. In the last case other rewards, such as access to venture capitalists or a customer base and networking events, can be provided. In such a study it would be interesting to investigate whether the participation of non-qualified persons is similar or influenced by the size of the money prize.

Our research shows that the non-serious participants did not significantly differ in demographic characteristics gender, age and country of residence. We believe that it is useful to extend the number of demographic control variables and to analyze whether non-qualified participants have common characteristics. In addition, we recommend inclusion of measures for education and working experience. It should be noted that we had information on education and working experience of Green Challenge participants available. But this information consisted of answers to open questions and appeared to be incomparable. Therefore we recommend using fixed classifications of education and working experience which are clearly understood by international respondents. If these measures are predictors for good performance, we argue that crowdsourcing is not the optimal tool for big money contests since crowdsourcing is open to every volunteer, independent of any proven skills or expertise. Instead a contest requiring a prequalification before participation would be more effective in generating the best performance of participants.

Chapter 8. Conclusion and Future Research

8.1. Introduction

This chapter concludes the thesis. We do not intend to repeat, in detail, the conclusions and discussions that are reported at the end of each individual case. Instead we address the overall conclusions that can be drawn from the three studies. It should be noted that in drawing our conclusions, we combined the results of the Tweakers.net and the NUfoto.nl study while the results of the Green Challenge study are considered separately. The reason for this approach is that the Tweakers.net and NUfoto.nl studies are quite comparable with no or small rewards, while the Green Challenge provided a different research setting in which extreme money rewards were offered.

Tweakers.net and NUfoto.nl have some other characteristics in common. According to Alexis.com the two sites generate similar traffic figures and are both are in the top 100 of Dutch sites. It should be noted that similar levels of popularity is relevant since we analyze the effects of reputation rewards. In addition the two studies have multiple characteristics in common such as a large number of respondents, which provide a robust basis for statistical analysis, analysis of non-contributors and contributors and an investigation of the same performance measures. The Green Challenge study on the other hand showed a smaller number of respondents and some deviating dependent variables or performance measures. However, the most important differentiator of the Green Challenge study is its €0.5 million reward which results in an incomparable research setting.

For these reasons, we combine the findings and conclusions of the Tweakers.net and NUfoto.nl study and treat the findings and conclusions of the Green Challenge study separately.

8.2. Summary of research questions

The central question in this thesis is how the motivations of online volunteers are related to their participation and performance in crowdsourcing activities and how rewards affect these relations. We expected that different motives have different effects and therefore we distinguish between intrinsic and extrinsic motivations. Intrinsic motivations drive people to engage in the activity because they find it interesting and derive spontaneous satisfaction

from the activity itself (Gagné and Deci, 2005; Calder and Staw, 1975) while extrinsic motivations imply that a person performs an activity for the sake of receiving compensation or other rewards (Frey and Obenholzer-Gee, 1997; Deci, 1971). Following the Work Preference Tool (Amabile et al, 1994), a tool measuring levels of motivation in adult people, we discern the intrinsic motives of pleasure and challenge and the extrinsic motives of desire for compensation and desire for recognition.

The decision to contribute is a participation measure indicating whether the person is an active contributor or does not provide a contribution (a so called non-contributor). Quantity, usefulness and novelty are performance criteria. Quantity is defined as an output measure, namely the number of contributions that a contributor in a certain time period provides. Usefulness refers to the value a contribution has for other visitors to the site or for the organizer of crowdsourcing activity. Finally, novelty means the newness of one's contribution.

We expected that intrinsic motivation is an important driver of participation and performance in crowdsourcing activities since it concerns voluntary activities. The effects of extrinsic motivation were expected to be conditional on the presence or absence of rewards. In addition we expected an interplay of intrinsic and extrinsic motivations resulting in enhancing and undermining effects on behavior. These interaction effects were expected when rewards are absent.

8.3. Findings and conclusions Tweakers.net and NUfoto.nl studies

According to our expectations, we found in the Tweakers.net and NUfoto.nl studies differences in the effects of intrinsic and extrinsic motivations. Also our expectation that the interaction between intrinsic and extrinsic motivation occurs, appeared to be true. The findings and conclusions on the effects per motivation type are described in the following paragraphs.

Intrinsic motivations an important driver of participation and performance

It can be concluded from the Tweakers.net and NUfoto.nl studies that intrinsic motivation is an important driver in crowdsourcing activities. The Tweakers.net study showed that both pleasure and challenge have positive effects on participation and performance, with the exception of the usefulness of contributions. In the NUfoto.nl study, effects of intrinsic motivations were somewhat limited: pleasure has a positive effect on quantity while

challenge has a positive effect on novelty. These results are consistent with the general notion that intrinsic motivation is a key driver of voluntary behavior.

Table 18 Testing of hypotheses 1, 2 and 3

		Tweakers.net	NUfoto.nl
Hypothesis 1	Intrinsic motivation of a community member has a positive effect on the decision to contribute to the online community	Supported	No significant regression model
Hypothesis 2	Intrinsic motivation of a community member has a positive effect on the quantity of contributions to the online community	Supported	Partly supported
Hypothesis 3	Intrinsic motivation of a community member has a positive effect on the novelty of contributions to the online community	Supported	Partly supported

Extrinsic motivations have negative or positive effects dependent on the absence or presence of rewards

Both studies confirm that effects of extrinsic rewards are dependent on the presence or absence of rewards. The Tweakers.net study shows that if rewards are absent, negative effects of extrinsic motivations on performance occur, while in the presence of rewards extrinsic motivations have positive effects on participation and performance.

The NUfoto.nl study confirms the findings of the Tweakers.net study, but adds that in the cases of the presence of rewards the relatedness of reward criteria is also relevant. Reward criteria are related whenever they communicate that a specific performance level should be met or surpassed to receive the reward. For example, reward criteria emphasizing that rewards are provided for mass contributions, are related to the performance aspect of quantity and not related to novelty of contributions. The NUfoto.nl study showed that when reward criteria are non-related no effects occur. When reward criteria are related to the performance aspect, extrinsic motivations have a positive effect on that specific performance aspect.

We would like to emphasize that non-related reward criteria do not have similar effects as the absence of rewards. When rewards are absent, extrinsic motivations have negative effects on performance while in the presence of rewards with non-related reward criteria, extrinsic motivations have no (positive or negative) effects.

The negative effects of extrinsic motivation on participation and performance in the absence of rewards can easily be explained: participation or performance simply does not satisfy the needs of the person. Conversely, offering rewards does not automatically result

in positive effects of extrinsic motivations; reward criteria have to be related to the performance aspect before a positive effect occurs. The reward criteria makes transparent in which cases a reward will be received and the person can satisfy his or her needs when performing well on the specified aspects.

Table 19 Testing of hypotheses 4a, 4b and 5

		Tweakers.net	NUfoto.nl
Hypothesis 4a	When rewards are provided, extrinsic motives related to these rewards have a positive effect on the decision to contribute to the online community	Supported	No significant regression model
Hypothesis 4b	When rewards are provided, extrinsic motives related to these rewards have a positive effect on quantity, usefulness and novelty, depending on the criteria defined to receive a reward.	Partly supported	Partly supported
Hypothesis 5	When rewards are absent, extrinsic motives related to these rewards have a negative effect on the decision to contribute and on the quantity, usefulness and novelty of contributions.	Partly supported	n/a

Combination of intrinsic and extrinsic motivations results in enhancing or undermining effects

The Tweakers.net study shows that when rewards are absent, an interaction between intrinsic and extrinsic motivations occurs. This interaction results in an improved performance of people who are highly intrinsically and lower extrinsically motivated and lower performance of people that are both highly intrinsically and highly extrinsically motivated.

When offering rewards, reward criteria indicate how contributors should perform to receive the reward. Contributors can experience this as a restriction of their autonomy; they are being persuaded to behave in a certain manner that they may not like. In the absence of rewards such guidance does not occur, the perceived autonomy is in that case higher. People who are only high intrinsically motivated, will perceive autonomy to be higher in the absence of rewards and will show optimal performance. If they also are highly extrinsically motivated, the absence of rewards will reduce their performance because they can not satisfy their desire for rewards.

Financial and reputation rewards show different interplay between intrinsic and extrinsic motivation

The findings of the NUfoto.nl study show that the provision of rewards does not abolish the interaction effects in all cases; there appears to be a difference in interaction effects when financial rewards or reputation rewards are offered. When reputation rewards combined with vague reward criteria are offered, an interplay between intrinsic and extrinsic motivation occurs. As a consequence people that are mainly highly intrinsically motivated will improve their performance, while people with high intrinsic and high extrinsic motivation will perform worse. When reputation rewards with clear reward criteria or financial rewards are offered, intrinsic and extrinsic motivation no longer interact. Thus, the clearness of reward criteria causes an interplay between intrinsic and extrinsic motivations when reputation rewards are offered while this not the case when financial rewards are offered. Therefore clearness of reward criteria influences the effectiveness of reputation rewards.

Financial rewards provided through their tangible nature signal that the reward-giver finds engaging in the task important. For reputation rewards this is not obvious because it is not always clear whether reputation rewards pose 'costs' to the reward giver. When specifying clear reward criteria, the reward giver emphasizes the importance of proper execution of the task.

Table 20 Testing of hypothesis 6

		Tweakers.net	NUfoto.nl
Hypothesis 6	When rewards are absent, extrinsic and intrinsic motivation interact in such a way that at low levels of extrinsic motivation the positive effects of intrinsic motivation on the decision to contribute, and on the quantity, usefulness and novelty of contributions increase, and at high levels of extrinsic motivation the positive effects of intrinsic motivation on the decision to contribute, and on the quantity, usefulness and novelty of contributions decrease.	Partly supported	Partly supported; clearness of reward criteria should be included in hypothesis

Summary of conclusions

In Table 21, the direct and indirect effects of intrinsic and extrinsic motivation in the absence and presence of rewards are summarized. We show our hypothesized effects separately on the basis of the literature review and the effects that we found in our empirical studies.

Table 21 Summary of direct and indirect effects of intrinsic and extrinsic motivation on participation and performance in absence and presence of rewards

	Type of reward	Relatedness of reward criteria	Clearness of reward criteria	Effects of intrinsic motivations on decision to contribute, quantity and novelty	Effects of extrinsic motivations on decision to contribute, quantity and novelty	Interaction effects of intrinsic and extrinsic motivations on quantity and usefulness
On basis of literature review (see also Table 3)						
Absence of rewards	Not relevant			+	—	—
Presence of rewards	Financial rewards	Not relevant		+	+	0
On basis of our empirical research						
Absence of rewards	Independent			+	—	—
Presence of rewards	Reputation rewards	Non-related	Vague	+	0	—
		Non-related	Clear	+	0	0
		Related	Vague	+	+	—
		Related	Clear	+	+	0
	Financial rewards	Non-related	Not relevant	+	0	0
		Related	Not relevant	+	+	0

+ = positive effect
0 = no effect
— = negative effect

It is clear that the hypothesized effects of intrinsic and extrinsic motivations in the absence of rewards are confirmed in our empirical studies. When rewards are present, the situation is more complex than hypothesized. Reward criteria also influence the effects of motivations. As a consequence, optimal reward design includes the relatedness and clearness of reward criteria.

We explained that the relatedness of reward criteria is conditional for achieving direct positive effects on the desired performance aspect. When reward criteria are not related, no positive or negative effect on performance occurs. In addition we explained that clearness of reward criteria is relevant for reputation rewards. Contrary to financial rewards, reputation rewards do not clearly pose costs on the reward giver. Therefore specification of reward criteria are needed to emphasize that execution of the task is important for the

reward giver. If reward criteria are vague, negative interaction effects between intrinsic an extrinsic motivation occur, similar to the situations in which rewards are absent.

8.4. Findings and conclusion Green Challenge study

In this thesis just a single study investigates the effects of motivation in the presence of big money rewards: the Green Challenge, an online innovation contest in which a big money prize (€0.5 million) was offered to the winner. We expected that the extreme money prize would be disruptive for the effects of motivation on performance and therefore we chose an explorative rather than hypothesis testing study.

In accordance with the previous studies we found that intrinsic motivation is also a driver of performance in this contest. But in this study, no positive effect of intrinsic motivation was found, solely a negative effect of pleasure on usefulness and novelty. Additional analysis uncovered that the group of participants was not homogenous. About half of the participants were not seriously qualified for participation while the other half could be considered serious candidates for winning the contest. These non-serious participants had significantly higher scores for the motive of pleasure and performed significantly worse. Therefore, we expect that the non-serious participants heavily influenced the relation between intrinsic motivation and performance of the total group of respondents and that serious participants show a different relation. Datasets of the two groups were too small to prove our new proposition that serious and non-serious participants show different effects of intrinsic motivation on performance.

No effects on performance were found for the motive desire for recognition. We believe that the size of the financial reward is so extreme that it overrules the effects of the reputation rewards and therefore no effects of the motive desire for recognition are found.

On the basis of the previous studies, we concluded that rewards can have an effect on multiple performance aspects. Since receiving the money prize was clearly linked to three performance aspects (usefulness, novelty and sustainability), we expected that the motive, desire for compensation, has a positive effect on these three performance aspects. To our surprise we found that the desire for compensation only has a positive effect on novelty and not on the other performance aspects. We believe that the single effect is caused by the Green Challenge communication. The Green Challenge does not provide information how winners of previous challenges scored on each performance aspect and it can only be

concluded from press releases on the winning submission that novelty was the main criterion.

8.5. Scientific contributions

Refined model of the effects of rewards and motivations on voluntary behavior
This study contributed to the motivation literature because we constructed a refined model projecting the effects of rewards and motivations on voluntary behavior. The refinement consists of new elements that are added to the model. First, we measure both intrinsic and extrinsic motivation levels, while psychologists studying voluntary behavior focus on intrinsic motivation. They measure intrinsic motivations and behavior of non-rewarded and rewarded groups. Differences in behavior between the rewarded and non-rewarded groups are explained through changes in intrinsic motivations. Although not explicitly argued, these cognitive psychology researchers (e.g. Deci and Eisenberger) assume that only rewards arouse extrinsic motivation. Since our studies measure extrinsic motivation we illustrate that extrinsic motivations not only have effects in contexts where rewards are offered, but also in contexts where rewards are absent.

A second new element of our theoretical model is that we make a distinction between direct and interaction effects of motivations. Specifically, the interaction effects must not be neglected because the interaction of intrinsic and extrinsic motivations has important consequences for performance in situations where rewards are absent. To interpret the interaction effects, it is necessary to distinguish motivation profiles in which a different combination of low versus high levels of intrinsic motivations are made. Deci et al (1999) already argued that persons with high intrinsic motivation behave differently than persons with low intrinsic motivations. Deci and colleagues explicitly stated that the CET and SDT are only applicable for challenging tasks in which participants are expected to have high intrinsic motivation. Deci and co-authors disputed the results of studies which consisted of non-challenging tasks assuming that participants were not highly intrinsically motivated. In this thesis we show that the group of highly intrinsically motivated volunteers is not homogeneous: they do not perform identically. We demonstrate that in the absence of rewards, individuals with high intrinsic motivation and low extrinsic motivation show substantially better performance than volunteers that are highly intrinsically and extrinsically motivated. In addition, we do not limit the application of our model to highly intrinsically motivated volunteers, but analogous to GIT, our model also applies to persons who have low intrinsic motivation.

The last new element of the theoretical model is the inclusion of the reward type and reward criteria. The importance of the relatedness of the reward criteria was discovered more than 30 years ago (Kerr, 1975). So our conclusion that in presence of rewards with related reward criteria extrinsic motivation has a positive effect on performance is not new. Our contribution consists of a different conclusion: extrinsic motivations do not have the same effects in the absence of rewards and in the presence of rewards with non-related reward criteria. Until now it is believed that the absence of rewards does not have any negative impact on behavior. We show that in the absence of rewards, motivation has negative effects on performance, which is not equal to the neutral impact of extrinsic motivation when rewards with non-related reward criteria are offered.
The metastudy of Deci (1999) made clear that effects of non-tangible rewards differ from the effects of financial rewards. Differences are not explained in terms of reward criteria. Therefore our conclusions that the effectiveness of reputation rewards is influenced by the clearness of reward criteria and that financial rewards are not influenced by the clearness of reward criteria is also a contribution to the psychology literature.

Contributions to literature on online and open source communities
Multiple studies of online and open source communities showed contrary effects of motivations on the quantity of contributions. According to the studies summarized in
Table 1, extrinsic motivations have positive or negative effects on the quantity of contributions while. We were not able to trace whether rewards were present or absent in these studies. Our final model on the effects of motivation on participation and performance (see Table 21) which considers the absence or presence of rewards, confirms that extrinsic motivations can have different effects. We show that effects of extrinsic motivations heavily depend on the absence or presence of rewards: negative direct effects occur when no rewards are provided, while effects turn positive when rewards are offered. Therefore our model is able to explain the contrary findings of empirical studies.

In addition we contribute to the literature through our analysis of multiple performance aspects. We did not limit our motivation model to the quantity of contributions, but also added the performance aspects usefulness and novelty of contributions.

Solution to the psychology controversy?
The controversy between psychological schools of thought focused on the effects of financial rewards. Deci and cohorts argue that financial rewards always undermine behavior whereas Eisenberger and colleagues state that financial rewards can also have enhancing effects on behavior. Both groups of scholars base their argumentation on empirical results. The question is whether our new model (see Table 21) can explain these

conflicting empirical results. Answering this question requires a comparison of the effects of motivation in the absence of rewards and the effects of motivation in the presence of financial reward. We concluded that the effect of financial rewards is also affected by the relatedness of reward criteria. We assume that the reward criteria in the experiments described by Deci and Eisenberger were related since they explicitly use the term performance contingent rewards. We focus on the effects of motivation on quantity since this in the main performance aspect that the studies of Deci and Eisenberger have in common.

Deci and Eisenberger do not make a distinction between direct and indirect effects or between effects of intrinsic and extrinsic motivation. They solely measure the net behavior in non-rewarded and rewarded groups. By comparing the behavior of these two groups, the effect of rewards is determined. In the sections below, we will apply the same approach (i.e. comparing the non-rewarded and rewarded groups) to our model in order to determine the net effects of intrinsic and extrinsic motivations, including direct and interaction effects.

Table 22 Comparison of behavior of non-rewarded and rewarded volunteers

	Type of reward	Relatedness of reward criteria	Clearness of reward criteria	Effects of intrinsic motivations on quantity	Effects of extrinsic motivations on quantity	Interaction effects of intrinsic and extrinsic motivations on quantity
Absence of rewards (non-rewarded volunteers)				+	—	—
Presence of rewards (rewarded volunteers)	Financial reward	Related		+	+	0

Our studies show that both in the presence and absence of rewards the effects of intrinsic motivation are positive. When comparing the direct effects of extrinsic motivation in the rewarded and non-rewarded groups, people that are highly extrinsically motivated show better performance when a reward is present. People who are less extrinsically motivated, will also demonstrate better performance, but the difference between the rewarded and non-rewarded group will be smaller.

Through offering financial rewards, the interaction between intrinsic and extrinsic motivation will disappear. As a consequence people with high intrinsic and low extrinsic motivation will show lower performance when rewarded as compared to not being rewarded. The group of highly intrinsically and highly extrinsically motivated people will show the contrary: when rewarded, they show better performance compared to not being rewarded. This can also be concluded when comparing the following two figures which show the net effects of motivations on performance in a unrewarded group (see Figure 19) and in a rewarded group (see Figure 20).

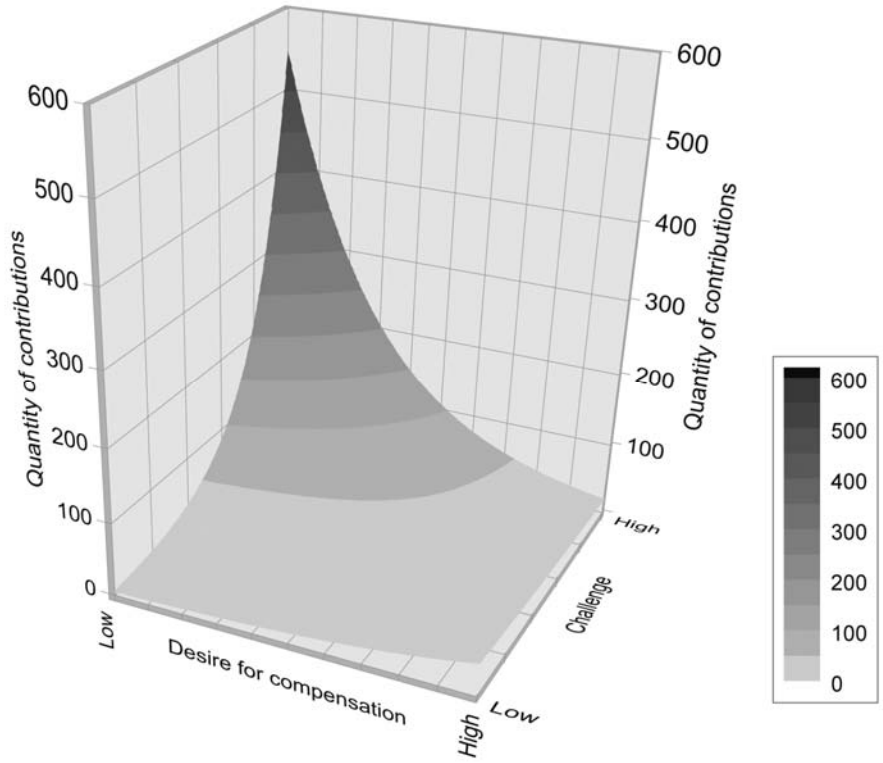

Figure 19 Direct and interaction effects of challenge and desire for compensation on quantity of contributions – Tweakers.net

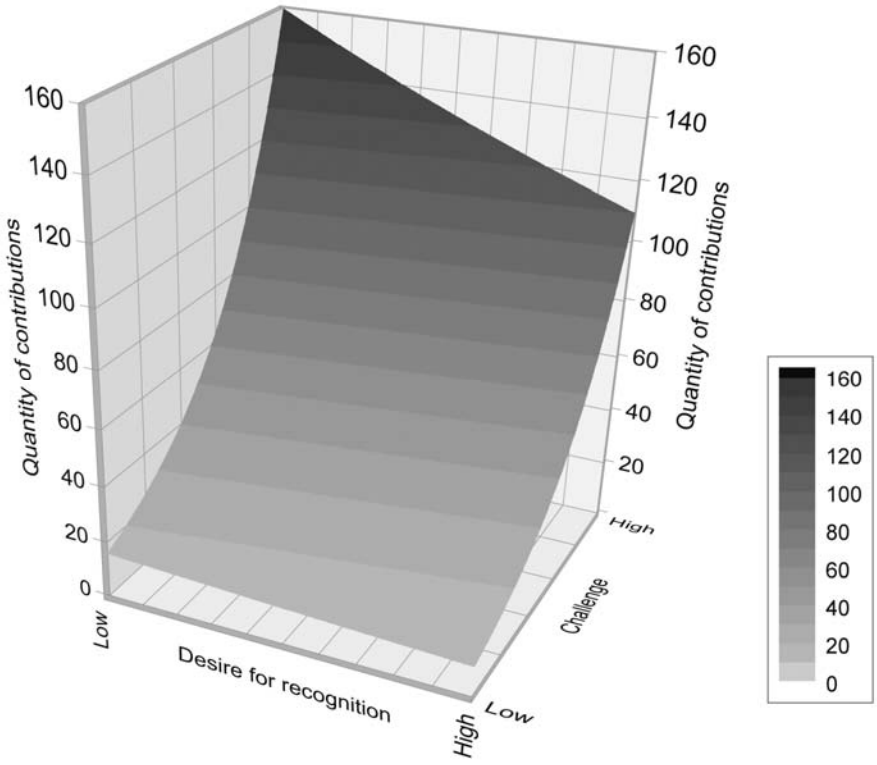

Figure 20 Direct effects of challenge and desire for compensation on quantity of contributions – Tweakers.net

Contributors that are mainly highly intrinsically motivated provide substantially higher numbers of contributions when not rewarded as compared to the situation in which they are rewarded. Contributors that are both highly intrinsically and highly extrinsically motivated perform better in the rewarded situation.

As a consequence, offering rewards is beneficial for people that have high intrinsic and extrinsic motivation while it is counter effective for people with high intrinsic motivation and low extrinsic motivation. The effect for the first group is described by Eisenberger, while the second group fit with the conclusions of Deci and colleagues.

Therefore different motivation profiles (i.e. different combinations of low and high intrinsic and extrinsic motivations) can explain the controversy. Since both groups of scholars did not measure extrinsic motivation, we can not prove that Deci bases his

conclusions on experiments with high intrinsically and low extrinsically motivated people. Nor can we examine whether Eisenberger found a basis for his view in experiments with high intrinsically and extrinsically motivated people. But we found some indications that participants of the lab experiments underlying the two meta-analyses (Deci et al, 1999; Eisenberger, Pierce and Cameron, 1999) have different motivation profiles.

We assessed the way participants are recruited for the laboratory experiments and discovered that in a number of experiments, participants received a reward; either a small money amount (Kruglanski et al, 1975) or extra credits for their study (Rosenfield et al, 1980; Eisenberger, Rhoades and Cameron, 1999). It can be argued that when receiving a reward, more people with high extrinsic motivation participate. All these studies show a positive Cohen's *d* for self-reported behavior which means that these participants showed higher performance (e.g. time spent on the activity) in rewarded activities compared to non-rewarded activities. This is in line with our argumentation that people with high intrinsic and high extrinsic motivation will perform better in rewarded activities compared to non-rewarded activities. Deci included fewer experiments in which participants were rewarded compared to Eisenberger. This provides an indication that the conclusions of the SDT and CET are mainly based on experiments with participants with high intrinsic and low extrinsic motivation.

Effects of extreme money rewards

Research on motivation in voluntary activities focuses on experiments in which no financial rewards are provided and on experiments in which small prize amounts are provided. It is recognized that the size of the financial reward is influencing the effect of this reward (Eisenberger and Armali, 1997; Eisenberger and Selbst, 1994) and effects of small rewards (less than USD 1) are compared with the effects of large rewards (up to a few dollars). Eisenberger concludes that large rewards have positive effects on intrinsic motivation and behavior while small rewards have detrimental effects. Our study of the Green Challenge innovation contest shows that extreme money rewards can not be considered as a type of large money rewards since it has disruptive effects on the relation between motivation and performance. Therefore the main contribution of this study is that we show that the current classification of no, small and large money rewards is not sufficient. One category should be added: extreme money rewards.

The fact that extreme money rewards attract non-serious participants that do not qualify for this contest (what we called the 'idols' effect) is not recognized in the literature. Existing motivation literature (Amabile, 1993) argues that whenever the task is too challenging, the

person gets de-motivated and does not engage in the activity. It appears that big money rewards have very powerful effects and change the behavior of the person.

8.6. Managerial impact

8.6.1. Recommendations for crowdsourcing design

Our studies showed that the effectiveness of rewards is very much dependent on the motivation profile of the people engaged in the crowdsourcing activity and emphasized the importance of reward criteria. In line with our findings, we formulated the following recommendations for firms that are or want to become engaged in crowdsourcing activities.

Rely on the minority of your online community members …

We conclude that people with high intrinsic and low extrinsic motivations are the best performers in unrewarded activities. Therefore it is possible to select a non-rewarded situation and rely on those community members that are mainly intrinsically motivated. The benefit of this option is cost effectiveness since rewards increase the costs of a crowdsourcing initiative. A possible disadvantage is that the online community is too small and does not provide a sufficient number of highly intrinsically motivated people to deliver the desired (cumulative) performance. In order to attract as many as possible primarily highly intrinsically motivated members, the firm can emphasize the fun and challenging aspects of the crowdsourcing activity or use current contributors to express why they experience so much pleasure and challenge in the crowdsourcing activity.

… or trust in the effects that rewards have on the majority of your online community members

In some cases, it can be that the group of primarily intrinsically motivated people is too small to provide the desired number of useful contributions (e.g. when starting an online community). In those cases it would be a better option to promise the community members a reward for their crowdsourcing activities, since people that are also highly extrinsically motivated will improve their performance in rewarded situations. Since the group of people that are both highly intrinsically and extrinsically motivated is most likely substantially larger than the group of people that are only highly intrinsically motivated, the cumulative performance of the community will improve.

Consider rewards seriously only when there is a need for a specific level of performance

Offering rewards is also a serious option when you want to specify the desired performance much more, for example in cases where the average usefulness of contributions is disappointing. Through the reward, or more specifically through the reward criteria, the crowdsourcing firm can more clearly communicate which contributions the firm would like to receive. Based on our results a firm can expect that rewards, with specific reward criteria, reduce the performance of highly intrinsically motivated people since it negatively affects their perceived self-determination. But again it will have a positive impact on the, much larger, group of people that are also extrinsically motivated. Therefore, we argue, for example, that YouTube should seriously consider the offering of financial rewards for very useful user generated content in order to stimulate the overall attractiveness of its website[43].

When promising rewards, communicate related and clear reward criteria

The results of the NUfoto.nl study especially showed the impact of reward criteria. The positive effects of rewards are limited to those situations where reward criteria communicate which performance aspects should be addressed. In other words, if a crowdsourcing firm would like to improve the usefulness of contributions and not necessarily the quantity of contributions, people should be informed that meeting or exceeding certain usefulness levels will be the basis for receiving the reward. When crowdsourcing firms wish to offer reputation rewards, attention should be paid to the clearness of the reward criteria since vague criteria will influence the effectiveness of reputation rewards.

Filter out non-serious participants

It appears that crowdsourcing initiatives offering extreme money rewards attract large numbers of non-serious participants. Since these non-serious participants heavily reduce the average quality of contributions, it is recommended to filter out these non-serious participants. In the Green Challenge study we developed of three questions which filter out non-serious participants of an online innovation contest very quickly. Those filters save a lot of time since the assessment procedure by the expert jury can be restricted to serious candidates.

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[43] NRC Handelsblad, Website Youtube gaat inkomsten delen, 29 January 2007, page 9.

8.6.2. Towards a crowdsourcing classification

Based on the size of the rewards we can distinguish four types of crowdsourcing initiatives. We can also suggest, based on the results of our three studies, which motivation orientation of participants would drive optimal performance.

The Tweakers.net and NU.nl studies prove that the combination of a person's intrinsic and extrinsic motivation, the so called motivation orientation, is important is forecasting the effects of the absence or presence of rewards. The study on Tweakers.net shows that in the absence of financial rewards contributors who are mainly intrinsically motivated are the best performers, while the study on NU.nl shows that when small financial rewards are offered contributors with high extrinsic motivation are also good performers. Although we were not able to determine the motivation orientation of the best performers in the Green Challenge study, due to disturbance of non-serious contributors, we would like to propose our view on which motivation orientation of a contributor results in optimal performance when using financial rewards of different sizes.

First, we distinguish four sizes of rewards: no, small, large or extreme financial rewards. Small rewards are those prize amounts that do not fully compensate the contributors for the effort that they have undertaken or the value that they contributed. For example the money that a photographer receives from NUfoto.nl (€50) is not representative of the amount a professional photographer would get for a news photo (up to several thousand euros[44]). Large rewards are defined as financial rewards that fully reflect the effort needed or the value delivered by the contributor. InnoCentive, a crowdsourcing firm seeking solutions for complex problems that universities or R&D departments of firms cannot solve themselves, make the prize amount per challenge dependent on the complexity of the problem. Based on the complexity points per challenge, InnoCentive determines a fair prize for solving it[45]. Extreme rewards are financial rewards that exceed the effort put in the contribution. Although the Green Challenge participants had to spend quite some time in the preparation of the submission, it can be concluded that the development of a high level business plan is overpaid with the prize amount of €0.5 million.

Dependent on the size of the reward, four types of crowdsourcing can be distinguished. When in a crowdsourcing initiative no financial rewards are offered, we call it Free Sourcing. Crowdsourcing initiatives offering small rewards are classified as Gift Sourcing.

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[44] http://www.tonborsboom.denieuwsfoto.nl/tarievenmedia.php

[45] Interview Alph Bingham, co-founder and director of InnoCentive

Expert Sourcing refers to crowdsourcing initiatives in which large amounts, representing fair compensation for the expertise or contribution, are provided. Finally, Game Sourcing refers to crowdsourcing initiatives that provide extreme money rewards.

We argue that the motivation orientation of optimal performers differ per crowdsourcing type, see Table 23.

Table 23 Motivation orientation optimal performers per crowdsourcing type

Crowdsourcing type	Size of financial reward	Motivation orientation optimal performers
Free Sourcing	No financial reward	High intrinsic – low extrinsic motivation
Gift Sourcing	Small financial reward	High intrinsic – low or high extrinsic motivation
Expert Sourcing	Large financial reward	High intrinsic – high extrinsic motivation
Game Sourcing	Extreme financial reward	Low intrinsic – high extrinsic motivation

The motivation orientation of optimal performers in the case of Free Sourcing is in line with the findings in the Tweakers.net study. In the absence of financial rewards, high intrinsic motivation is required for voluntary contributions while high extrinsic motivation would be counter-productive since needs for compensation are not satisfied. In the case of Gift Sourcing, extrinsic motivation may become relevant, due to the presence of a financial reward. Since the reward is not very substantial, we question whether high extrinsic motivation is required for optimal performance. This perspective is in line with the results of the NUfoto.nl study in which for some performance aspects (e.g. novelty) the performance was independent of the level of extrinsic motivation. In these cases, intrinsic motivation appeared to be the main driver of the performance aspect.

Although we can not underpin our perspective on Expert Sourcing with empirical research, we argue that in those initiatives high extrinsic motivation becomes a key denominator of good performance. Since the reward is substantial (e.g. can be compared with compensation received in a normal job) the contributor's desire for compensation may be fulfilled. Still intrinsic motivation is expected to remain an important role in Expert Sourcing, since there is no single contractual obligation for the contributor to engage in the activity and there is no guarantee that the contributor will receive the reward.

As shown in the Green Challenge study, extreme financial rewards appear to attract non-serious participants. Those non-serious participants do not perform well. At the same time, the Green Challenge was able to garner the interest of serious participants that performed well. We expect that these serious participants are mainly motivated by the money prize and thus extrinsic motivation is the main driver of good performance in the case of Game

Sourcing. Unfortunately we were not able to test our view with empirical evidence since the group of serious respondents was too small for reliable quantitative analysis.

It should be noted that Free and Gift Sourcing can not be used for all crowdsourcing activities. We expect that those types of crowdsourcing cannot be applied to extensive tasks or tasks that require very valuable knowledge or expertise. In those cases the imbalance between effort and reward is too big.

8.7. Limitations and directions for future research

Although the NUfoto.nl study can be considered as a replication study of the Tweakers.net study, the two studies show some differences in their research setting. The crowdsourcing activity is not identical and the studies are executed in two different communities with different populations (for example a difference is female participation and the level of professionalism). Therefore it is recommended that a future study use a different methodology, namely an experiment within a single online community. In this experiment, participants have to provide the same contribution under different reward systems. It should be noted that when experiments with non-rewarded and rewarded groups are not executed in parallel, but subsequently, the order of being rewarded followed by being not-rewarded should be avoided since the offering of rewards can have effects on subsequent unrewarded activities (e.g. Eisenberger and Rhoades, 2001).

In the Tweakers.net and NUfoto.nl studies, we included 4 different motives. Other researchers included additional motives: obligation- or community-based intrinsic motivation (Nov, 2007; Franke and Shah, 2003) and the extrinsic motive 'future use value' (Füller et al, 2007; Jeppessen and Frederiksen, 2006; Kollock, 1999; Bitzer et al, 2006; Hars and Ou, 2002; Lakhani and Wolf, 2005; Lerner and Tirole, 2002). Obligation- or community-based motivation relates to altruistic and humanitarian concerns or fairness. 'Future use value' concerns the use of a new or improved product by the contributor him- or herself. We did not include these motives, since they were not clearly relevant for Tweakers.net and NUfoto.nl. We argue that in other communities these motives are surely relevant. Community-based motivations are for example relevant for online communities that have an altruistic objective (e.g. Wikipedia) and future use value is relevant for communities that focus on user innovation (e.g. product development of sporting equipment in an online sports community). Future researchers should investigate whether these motives have effects similar to the intrinsic and extrinsic motivations that we investigated.

It is recognized in cognitive psychology literature that intrinsic motivation is a key driver of voluntary behavior, but these researchers usually do not distinguish between the motives pleasure and challenge. Our studies show that pleasure and challenge do not always have equal effects. A possible explanation can be found in the routine of an activity. It can be argued that pleasure is more important in routine tasks while challenge has more of an impact in interesting and complex tasks. It should be noted that routine versus challenging tasks are part of the arguments of the controversy discussion (Deci, Ryan and Koestner, 2001) and that Deci and colleagues put more emphasis on task interest in their definition of intrinsic motivation and ignore pleasure (Lindenberg, 2001). Therefore the specific effects of the motives, pleasure and challenge, should be studied in both routine and non-routine tasks.

In our studies we discovered that financial rewards and reputation rewards have different effects, mainly dependent on the clearness of reward criteria. When reviewing the literature on rewards, we conclude that reputation rewards received relatively limited attention in the experiments of cognitive psychologists. Since it is concluded that status/reputation mechanisms behave differently in online versus offline contexts (Lampel and Bhalla, 2007), there is even more urgency to investigate reputation rewards in online contexts. It could be questioned, for example, whether size effects are also applicable for reputation rewards; e.g. which reputation rewards are considered small rewards and which are considered big rewards.

We found a negative relation between intrinsic motivation and performance in the Green Challenge study. We expect that the group of serious participants does not show a negative relation between intrinsic motivation and performance, but could not demonstrate this since our dataset was too small. Therefore, replication of our research within a contest with a larger number of participants should be the next step. We recommend using a stratified sample in which two groups of participants (serious and non-serious) are clearly distinguished.

In addition we believe that the Idols effect should be investigated in more detail. Whenever other determinants of non-serious participants are detected, solutions for avoiding the idols effect can be developed. It should be emphasized that solutions to avoid non-serious participation should be such that they do not negatively affect serious participation.

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Annex A Defining motivation and rewards

Motivation

The term motivation derives from the Latin word for movement (movere). Atkinson defines motivation as the immediate influence on direction, intensity and persistence of action (Atkinson, 1964). Vroom emphasizes that motivation drives choice of behavior in the sense that the person selects one activity from a range of alternative voluntary activities (Vroom, 1964). Common denominators of motivation definitions are factors or events that energize, channel and sustain human behavior in time (Steers et al, 2004).

Intrinsic and extrinsic motivations

According to the psychology literature, two types of motivation influence human behavior: intrinsic and extrinsic motivation. Intrinsic motivation involves that people perform an activity because they find it interesting and derive spontaneous satisfaction from the activity itself (Gagné and Deci, 2005). Calder and Staw (1975) state that intrinsic motivation indicates that people are prepared to undertake a task for immediate need satisfaction or for their own sake. Examples of intrinsic motivations are feelings of pleasure and feelings of challenge (Amabile et al, 1994). Challenge involves the desire to learn or improve skills, intellectual interest or curiosity (Amabile et al, 1994). Extrinsic motivation involves that a person performs an activity for the sake of receiving compensation or other rewards (Frey and Oberholzer-Gee, 1997; Deci, 1971). Examples of extrinsic motivation are the desire for financial or other tangible rewards and the desire for recognition (Amabile et al, 1994). Various forms of recognition can be distinguished: positive feedback (Deci et al, 1999), status seeking (Lampel and Bhalla, 2007), peer recognition and firm recognition (Jeppessen and Frederiksen, 2006).

Most psychology researchers represent intrinsic and extrinsic motivation on one continuum (Deci and Ryan, 1991; Vallerand, 2001). Such a continuum suggests that the more extrinsically driven a person is, the less intrinsically oriented he or she is (Covington and Müeller, 2001). Recently a dichotomy approach in which intrinsic and extrinsic motivation are represented on two independent continuums, is suggested (Model, 2005). Although the dichotomy approach is not (yet) fully supported with results of scientific studies, the approach seems to be consistent with practical examples of famous people combining high intrinsic motivation with high extrinsic motivation (Amabile, 1993).

Rewards

We observe that in psychology literature the terms motivation and rewards are used interchangeable. Not only rewards and extrinsic motivation are used as synonyms. We argue that although rewards and extrinsic motivation are related concepts, they are not identical. We consider motivation as a psychological feature that arouses a person to action, while rewards are the goal objectives that reinforce behavior (Porter, 1970). So motivation is an internal condition while rewards are provided by external parties. In addition, motivation is an individual phenomenon (Mitchell, 1982) which can differ per person while rewards identical for every participant.

Best known and commonly used rewards in crowdsourcing are money prizes or the so called financial rewards. Non-financial rewards could either be tangible rewards such as iPods, 't shirts, cars etcetera or the non-tangible social rewards. Examples of social rewards used for online volunteers are the publication of contributions on the website and peer rating systems. Publication of contributions makes the expertise of a person on a subject visible and gives rise to psychic pays-off such as self-efficacy and self-esteem (Butler et al, 2002). Peer rating systems or reputation systems aggregate a person's behavior in a single value (Dellarocas, 2003; Antoniadis and Le Grand, 2009). When these values are published on the website, high values will increase the reputation of a person within the community. In addition persons with high scores can be granted additional benefits such as exclusive titles, for example 'power' or 'godlike'contributor.

Besides the type of rewards also reward contingencies can influence the effect a reward has. In the following table various reward contingencies are listed.

Table 24 Typology of reward contingencies (Ryan et al, 1985; Deci et al, 1999; Cameron 2001)

Reward contingency	Description
Task non-contingent	Rewards delivered regardless task involvement
Task contingent	Rewards given for doing the task
Engagement contingent	Rewards for engaging in the activity without the requirement to finish the task
Completion contingent	Rewards for finishing or completing the task
Performance contingent	– Rewards for executing a complex activity, for example solving a problem – Rewards for achieving – Rewards for surpassing a specific score – Rewards for meeting or exceeding others

Annex B Websurvey Tweakers.net

Onderdeel 2a. De volgende stellingen gaan over jouw drijfveren om op Tweakers nieuwsartikelen te reageren. Door op deze nieuwsartikelen te reageren, laat je zien welke kennis en inzichten je op ICT gebied hebt. Vandaar dat in de vragen regelmatig deze termen voor komen.
Voor elke stelling moet je aangeven in hoeverre je het eens of oneens bent.

	Helmaal oneens	Oneens	Enigszins oneenst	Enigzins eens	Eens	Helemaal eens
Ik wil graag dat andere mensen zien hoe goed mijn ICT kennis en inzichten.zijn	☐	☐	☐	☐	☐	☐
Door reacties op nieuwsberichten te geven, wil.ik ontdekken hoe goed mijn ICT kennis en inzichten zijn.	☐	☐	☐	☐	☐	☐
Het geld dat ik met mijn ICT kennis en inzichten kan verdienen, is belangrijk voor mij.	☐	☐	☐	☐	☐	☐
Ik geef er de voorkeur aan om complexe ICT nieuwsonderwerpen zelf te doorgronden.	☐	☐	☐	☐	☐	☐
Nieuwsgierigheid is voor mij een belangrijke drijfveer om te reageren op ICT nieuwsitems.	☐	☐	☐	☐	☐	☐
Ik vind het belangrijkste dat ik geniet van het reageren op ICT nieuwsitems.	☐	☐	☐	☐	☐	☐
Ik vind het leuk om reacties op complexe ICT nieuwsitems te geven.	☐	☐	☐	☐	☐	☐
Reacties geven op ICT nieuwsitems is voor mij een belangrijk middel om mij te uiten.	☐	☐	☐	☐	☐	☐
Ik ben me zeer bewust van mijn financiele doelen tijdens het tonen van mijn ICT kennis en inzichten.	☐	☐	☐	☐	☐	☐

Onderdeel 2b.

	Helmaal oneens	Oneens	Enigszins oneenst	Enigzins eens	Eens	Helemaal eens
Ik reageer liever op simpele onderwerpen dan op conplexe onderwerpen.	☐	☐	☐	☐	☐	☐
Ik vind het prettig als iemand aangeeft aan welke criteria goede reacties op ICT nieuwsitems moeten voldoen.	☐	☐	☐	☐	☐	☐
Het maakt mij niet uit hoe goed of slecht mijn reactie op een ICT nieuwitems is, ik voel me tevreden als ik zelf een nieuwe ervaring heb opgedaan.	☐	☐	☐	☐	☐	☐
Waardering voor mijn ICT kennis en inzichten door andere mensen, motiveert mij sterk.	☐	☐	☐	☐	☐	☐
Ik geniet ervan om zo ingespannen met nieuwsreacties bezig te zijn, dat ik alle andere dingen vergeet.	☐	☐	☐	☐	☐	☐
Ik vind mijzelf succesvol als ik betere reacties op ICT nieuwsitems lever dan andere mensen.	☐	☐	☐	☐	☐	☐
Hoe moelijker het onderwerp van een ICT nieuwsitem, des te leuker ik het vind een reactie te geven.	☐	☐	☐	☐	☐	☐
Het heeft geen zin om goede reacties op ICT nieuwsitems te geven als niemand ze leest.	☐	☐	☐	☐	☐	☐
Ik geniet van deelname aan simpele ICT nieuwsdiscussies.	☐	☐	☐	☐	☐	☐
Ik ben benieuwd wat andere mensen vinden van mijn reacties op ICT nieuwsitems.	☐	☐	☐	☐	☐	☐

Onderdeel 2c.

	Helmaal oneens	Oneens	Enigszins oneenst	Enigzins eens	Eens	Helemaal eens
Ik denk zelden aan financiële opbrengsten wanneer ik mijn ICT kennis en inzichten toon.	☐	☐	☐	☐	☐	☐
Ik moet het gevoel krijgen dat ik iets voor mijn reacties op ICT nieuwsitems terug krijg.	☐	☐	☐	☐	☐	☐
Door te reageren op ICT nieuwsitems wil ik mijn kennis en vaardigheden verbeteren.	☐	☐	☐	☐	☐	☐
Ik lever het liefst reacties op ICT nieuwsitems als duidelijk is aan welke criteria ik moet voldoen.	☐	☐	☐	☐	☐	☐
Ik ben mij zeer bewust van de voordelen die mijn ICT kennis en inzichten mij op kunnen leveren.	☐	☐	☐	☐	☐	☐
Ik vind het geven van reacties op ICT nieuwsitems minder belangrijk dan wat zij opleveren.	☐	☐	☐	☐	☐	☐
Zolang ik geniet van het geven van reacties op ICT nieuwsitems, maak ik me niet druk over betaling.	☐	☐	☐	☐	☐	☐
Het maakt mij niet zoveel uit wat andere mensen van mijn reacties op ICT nieuwsitems vinden.	☐	☐	☐	☐	☐	☐

Annex C Websurvey NUfoto.nl

Onderdeel 2a. De volgende stellingen gaan over jouw drijfveren om nieuwsfoto's te maken en te publiceren. Voor elke stelling moet je aangeven in hoeverre je het eens of oneens bent.

	Helmaal oneens	Oneens	Enigszins oneenst	Enigzins eens	Eens	Helemaal eens
Ik wil graag dat andere mensen zien hoe goed ik ben als nieuwfotograaf.	☐	☐	☐	☐	☐	☐
Door foto's te maken en te publiceren wil ik ontdekken hoe goed ik ben in nieuwsfotografie.	☐	☐	☐	☐	☐	☐
Ik vind het leuk om nieuwsfoto's te maken en te publiceren die voor mij origineel zijn.	☐	☐	☐	☐	☐	☐
Het geld dat ik met nieuwsfoto's kan verdienen is belangrijk voor mij.	☐	☐	☐	☐	☐	☐
Ik geef er de voorkeur aan zelf te ontdekken hoe ik goede nieuwsfoto's kan maken.	☐	☐	☐	☐	☐	☐
Nieuwsgierigheid is voor mij een belangrijke drijfveer om nieuwsfoto's te maken.	☐	☐	☐	☐	☐	☐
Ik vind het leuk om nieuwsfoto's in moeilijke omstandigheden te maken.	☐	☐	☐	☐	☐	☐
Nieuwsfoto's maken en publiceren is voor mij een belangrijk middel om mij te uiten.	☐	☐	☐	☐	☐	☐
Ik ben me zeer bewust van mijn financiële doelen met het maken en publiceren van nieuwsfoto's.	☐	☐	☐	☐	☐	☐

Onderdeel 2b.

	Helmaal oneens	Oneens	Enigszins oneenst	Enigzins eens	Eens	Helemaal eens
Ik mmak liever gemakkelijke nieuwsfoto's dan foto's die mij veel tijd en moeite kosten.	☐	☐	☐	☐	☐	☐
Ik vind het prettig als iemand aangeeft aan welke criteria goede nieuwsfoto's moeten voldoen.	☐	☐	☐	☐	☐	☐
Het maakt mij niet uit hoe goed of slecht mijn nieuwsfoto's zijn, ik voel me tevreden als ik zelf een nieuwe ervaring heb opgedaan.	☐	☐	☐	☐	☐	☐
Waardering voor mijn nieuwsfoto's door andere mensen, motiveert mij sterk.	☐	☐	☐	☐	☐	☐
Ik geniet ervan om zo ingespannen met nieuwsfoto's bezig te zijn, dat ik alle andere dingen vergeet.	☐	☐	☐	☐	☐	☐
Ik vind mijzelf een succesvolle nieuwsfotograaf als ik betere foto's maak en publiceer dan andere mensen.	☐	☐	☐	☐	☐	☐
Hoe lastiger het is om goede nieuwsfoto's te maken, des te leuker ik het vind.	☐	☐	☐	☐	☐	☐
Het heeft geen zin om goede nieuwsfoto's te maken en te publiceren als niemand ze bekijkt.	☐	☐	☐	☐	☐	☐
Ik geniet van het maken van simpele nieuwsfoto's.	☐	☐	☐	☐	☐	☐
Ik ben benieuwd wat andere mensen vinden van mijn nieuwsfoto's.	☐	☐	☐	☐	☐	☐

Onderdeel 2c.

	Helmaal oneens	Oneens	Enigszins oneenst	Enigzins eens	Eens	Helemaal eens
Ik denk zelden aan financiële opbrengsten wanneer ik nieuwsfoto's maak en publiceer.	☐	☐	☐	☐	☐	☐
Ik moet het gevoel krijgen dat ik iets voor het maken en publiceren van mijn nieuwsfoto's terug krijg.	☐	☐	☐	☐	☐	☐
Door nieuwsfoto's te maken, wil ik mijn fotografiekennis en -vaardigheden verbeteren.	☐	☐	☐	☐	☐	☐
Ik maak en publiceer het liefst nieuwsfoto's als duidelijk is aan welke criteria ik moet voldoen.	☐	☐	☐	☐	☐	☐
Ik ben mij zeer bewust van de voordelen die mijn nieuwsfoto's mij op kunnen leveren.	☐	☐	☐	☐	☐	☐
Ik vind het maken van nieuwsfoto's minder belangrijk dan wat zij opleveren.	☐	☐	☐	☐	☐	☐
Zolang ik geniet van het maken en publiceren van nieuwsfoto's, maak ik me niet druk over de betaling voor mijn foto's.	☐	☐	☐	☐	☐	☐
Het maakt mij niet zoveel uit wat andere mensen van mijn nieuwsfoto's vinden.	☐	☐	☐	☐	☐	☐

Annex D Websurvey Green Challenge

Part 2a. The following statements focus on your motives to participate in the Green Challenge. Participation in the Green Challenge is understood as creation of solutions for saving the climate. Please indicate per statement to which extent you agree or disagree.

	Fully disagree	Disagree	Disagree to some extent	Agree to some extent	Agree	Fully agree
I prefer having someone set clear criteria for me in participating in the Green Challenge.	☐	☐	☐	☐	☐	☐
I enjoy to create new solutions for climate change that are completely new for me.	☐	☐	☐	☐	☐	☐
As long as I enjoy participation in the Green Challenge, I am not concerned about what I am paid.	☐	☐	☐	☐	☐	☐
I am not concerned about what other people think of my solutions to climate change.	☐	☐	☐	☐	☐	☐
I enjoy trying to solve complex climate problems.	☐	☐	☐	☐	☐	☐
I am less concerned with what activities I do for the Green Challenge than what I get for it.	☐	☐	☐	☐	☐	☐
I enjoy solving climate change problems that is so absorbing that I forget everything else.	☐	☐	☐	☐	☐	☐
I do not experience social responsibility when participating in the Green Challenge.	☐	☐	☐	☐	☐	☐
I prefer working on solutions to climate change with clearly specified procedures and criteria.	☐	☐	☐	☐	☐	☐
Curiosity is the driving force behind my participation to the Green Challenge.	☐	☐	☐	☐	☐	☐
I am keenly aware of the personal benefits that I can receive for the Green Challenge participation.	☐	☐	☐	☐	☐	☐

Part 2b.

	Fully disagree	Disagree	Disagree to some extent	Agree to some extent	Agree	Fully agree
I am concerned about how other people are going to react to my solutions to climate change.	☐	☐	☐	☐	☐	☐
I feel that I am contributing to solutions to climate change when participating in the Green Challenge.	☐	☐	☐	☐	☐	☐
No matter what the outcome of the Green Challenge is, I am satisfied if I feel I gained a new experience.	☐	☐	☐	☐	☐	☐
I want that participation in the Green Challenge provides me with opportunities for increasing my knowledge and skills.	☐	☐	☐	☐	☐	☐
I believe that there is no point in finding a good solution to climate change if nobody else knows about it.	☐	☐	☐	☐	☐	☐
What matters most to me when participating in the Green Challenge, is enjoying what I do.	☐	☐	☐	☐	☐	☐
I seldom think of financial benefits when participating in the Green Challenge.	☐	☐	☐	☐	☐	☐
I have to feel that I am earning something for my participation in the Green Challenge.	☐	☐	☐	☐	☐	☐
The more difficult the find a solution to climate problems, the more I enjoy it.	☐	☐	☐	☐	☐	☐

Part 2c.

	Fully disagree	Disagree	Disagree to some extent	Agree to some extent	Agree	Fully agree
To me success in the Green Challenge means doing better than other participants.	☐	☐	☐	☐	☐	☐
I enjoy to figure out myself how climate problems can be solved.	☐	☐	☐	☐	☐	☐
I am keenly aware of the possibility to receive financial rewards when participating in the Green Challenge.	☐	☐	☐	☐	☐	☐
I feel responsible for providing solutions to climate change when participating in the Green Challenge.	☐	☐	☐	☐	☐	☐
I want other people to find out how good my solutions to climate change are.	☐	☐	☐	☐	☐	☐
I prefer to solve simple climate problems over problems that stretches my abilities.	☐	☐	☐	☐	☐	☐
I want to find out how good I really can be in providing solutions to climate problems.	☐	☐	☐	☐	☐	☐
I am strongly motivated by the money that I can earn in the Green Challenge.	☐	☐	☐	☐	☐	☐
Changing the climate is the driving force behind my participation in the Green Challenge.	☐	☐	☐	☐	☐	☐
I am strongly motivated by the recognition from other people I can earn for my participation in the Green Challenge.	☐	☐	☐	☐	☐	☐
I enjoy finding relative simple, straightforward solutions to climate change.	☐	☐	☐	☐	☐	☐

Annex E Criteria expert jury Green Challenge

Criterion	Item	Scale
Usefulness	a. The business plan is complete	1 = strongly disagree 2 = disagree 3 = neutral 4 = agree 5 = fully agree
	b. The business plan is concrete	1 = strongly disagree 2 = disagree 3 = neutral 4 = agree 5 = fully agree
	c. The business plan is realistic	1 = strongly disagree 2 = disagree 3 = neutral 4 = agree 5 = fully agree
	d. Realisability	1 = product and service development can not be realized within two years 2 = product or service development can be realized within 2 years but not the market launch 3 = product or service development and market launch can be realized within 2 years
	e. Usefulness of submission for Green Challenge organization	1 = not useful 2 = useful 3 = very useful

Criterion	Item	Scale
Novelty	a. In comparison with existing products or services, described product or service	1= is similar to available products or services (me-too product or service) 2 = is an improvement of existing products or services 3 = is an extension of existing products or services 4 = is next generation, new-to-the-market product or service 5 = is a radical or breakthrough product or service that create new industries or markets
	b. The described product or service is technological new	1 = strongly disagree 2 = disagree 3 = neutral 4 = agree 5 = fully agree
	c. The described product or service is new for the customer	1= strongly disagree 2 = disagree 3 = neutral 4 = agree 5 = fully agree
	d. The described product or service is novel sustainable product or service	1 = strongly disagree 2 = disagree 3 = neutral 4 = agree 5 = fully agree
Sustainability	a. The Reduction of greenhouse-gas emission	1 = is not explained convincingly 2 = is explained convincingly 3 = is proven with support of external information
	b. Annual CO2 reduction amount	1 = is not estimated 2= is roughly estimated 3 = is provided on basis of detailed calculations

Summary

Companies increasingly outsource activities to volunteers that they approach via an open call on the internet. The phenomenon is called 'crowdsourcing'. In general rewards are absent, in some cases the best contributions are rewarded by means of recognition on the website or by monetary prizes. To make effective use of crowdsourcing, it is important to understand what motivates these online volunteers and what is the influence of rewards. Therefore, this thesis examines the relationship between motivation and rewards on the participation and performance of online community members. Through the analysis of three crowdsourcing initiatives, which varied in reward systems, we investigated the effects of intrinsic and extrinsic motivation on the decision to contribute and on the quantity, usefulness and novelty of contributions that these online volunteers provide.

In the first study (Tweakers.net), financial rewards are absent while reputation rewards are present. It appears that in the absence of rewards, a person's combination of intrinsic and extrinsic motivation results in more extreme performance levels than when rewards are present. Persons that have high intrinsic, but low extrinsic, motivation showed the best performance in absence of rewards, while people that combine high intrinsic motivation with high extrinsic motivation performed substantially less, even in a rewarded situation. This led to the conclusion that a crowdsourcing initiative can save money on rewards when addressing people with high intrinsic motivation and low extrinsic motivation. Nevertheless, rewarding still appears effective since this group of people is smaller than the group with both high intrinsic and extrinsic motivation. Although the individual performance in the second group is much lower, the group performance appeared to be higher.

In the second study (NUfoto.nl), both financial rewards and reputation rewards were offered. This study showed the importance of reward criteria on the effects of motivation on performance. It also highlighted that clearness of reward criteria is more important for reputation rewards than financial rewards.

The last study (Green Challenge) can be classified as a research setting in which an extreme money reward is provided. This study, which was explorative in nature, showed that big money prizes attract some very qualified participants, but also a large number of non-serious participants. Filters for quick identification of non-serious participants are developed.

This thesis provides a contribution to the scientific literature by first presenting a refined model of the effects of rewards and motivation on voluntary behavior. Especially the combination of high and low levels of intrinsic and extrinsic motivation and our conclusion that the absence of rewards has important effects on the behavior of volunteers are major contributions. With this model we are able to explain contrary effects of motivation on performance in empirical studies of online voluntary behavior. Finally, we also provide a possible solution for the controversy between two schools of cognitive psychology that debate the effects of financial rewards on voluntary behavior.

Our results also have important implications for organizers of online communities, amongst others, regarding the effective application of reward systems. It also forms the basis of a crowdsourcing classification, in which crowdsourcing initiatives are classified on the basis of their reward systems: Gift sourcing (no or small financial rewards); Expert sourcing (large financial rewards) and Game Sourcing (extreme money rewards). Motivation profiles of optimal performers per crowdsourcing type are identified.

Samenvatting

Bedrijven besteden in toenemende mate activiteiten uit aan internetgebruikers die vrijwillig daaraan meewerken. Dit fenomeen wordt crowdsourcing genoemd ofwel het uitbesteden van bedrijfsactiviteiten aan de internetmenigte. Meestal krijgen deze vrijwillige internetgebruikers geen beloning voor hun activiteiten; in sommige gevallen worden de beste bijdragen beloond door het verhogen van iemands reputatie op de website of met financiële beloningen. Om effectief gebruik van crowdsourcing te maken, is het belangrijk om te begrijpen wat deze online vrijwilligers motiveert en wat de invloed van beloningen is. In dit proefschrift wordt de invloed van motivatie en beloning op de deelname en de prestaties van online community leden onderzocht. Door analyse van drie crowdsourcing initiatieven, die varieerden in beloningssystemen, onderzochten we de effecten van intrinsieke en extrinsieke motivatie op de beslissing om bij te dragen en op de hoeveelheid, het nut en de nieuwheid van de bijdragen die deze online vrijwilligers leveren.

In de eerste studie (Tweakers.net) zijn financiële beloningen afwezig maar worden wel reputatiebeloningen geboden. Uit deze studie blijkt dat in afwezigheid van beloningen, de combinatie van intrinsieke en extrinsieke motivatie van een persoon tot meer extreme prestaties leidt dan in aanwezigheid van beloningen. In afwezigheid van beloningen, presteren personen met hoge intrinsieke maar lage extrinsieke motivatie het beste, terwijl mensen die hoge intrinsieke motivatie combineren met hoge extrinsieke motivatie aanzienlijk minder presteren, zelfs als er beloningen aanwezig zijn. Dit leidt tot de conclusie dat een crowdsourcing initiatief geld kan besparen op beloningen door zich voornamelijk te richten op mensen met hoge intrinsieke en lage extrinsieke motivatie. Niettemin kan belonen een effectief instrument zijn, aangezien de groep hoog intrinsiek en laag extrinsiek gemotiveerde mensen kleiner is dan de groep met zowel hoge intrinsieke en extrinsieke motivatie. Hoewel de individuele prestatie in de tweede groep lager ligt, ook al worden beloningen geleverd, blijkt de groepsprestatie in deze situatie hoger te liggen vergeleken met de eerste groep.

In de tweede studie (NUfoto.nl) werden zowel financiële beloningen als reputatiebeloningen aangeboden. Deze studie toont aan dat criteria om een beloning te ontvangen, de effecten van motivatie op de prestaties beïnvloeden. Tevens werd duidelijk dat de helderheid van de criteria om beloningen te krijgen, belangrijker is voor reputatiebeloningen dan voor financiële beloningen.

De laatste studie (Green Challenge) is een onderzoeksomgeving waarbij de beste bijdrage wordt beloond met een extreem grote financiële beloning. Deze exploratieve studie laat zien dat grote geldprijzen een aantal zeer gekwalificeerde deelnemers aan kan trekken, maar ook een groot aantal niet-serieuze deelnemers. Filters voor een snelle identificatie van serieuze deelnemers zijn in deze studie ontwikkeld.

Dit proefschrift levert een bijdrage aan de wetenschappelijke literatuur door een verfijnd model van de effecten van beloningen en motivatie op vrijwillige gedrag te presenteren. In dit model maken we duidelijk dat de combinatie van hoge en lage niveaus van intrinsieke en extrinsieke motivatie (de zogenaamde motivatieprofielen) en het ontbreken van beloningen belangrijke effecten heeft op de deelname en prestaties van de online vrijwilligers. Door bestaande motivatie modellen aan te passen zijn we in staat om tegengestelde effecten van motivatie op prestaties, zoals gemeten in de empirische studies van online communities, te verklaren. Voorts bieden wij een mogelijke oplossing voor de controverse tussen twee scholen van cognitieve psychologen die een decenniumlang debat voeren over de effecten van financiële beloningen op vrijwillig gedrag.

Onze resultaten hebben tevens belangrijke praktische implicaties. We geven aan op welke wijze organisatoren van online communities het gedrag van haar community leden met beloningssystemen kan beïnvloeden. Tot slot vormen de resultaten de basis van een crowdsourcing typologie waarin crowdsourcing initiatieven worden ingedeeld op basis van hun beloning systemen: giftsourcing (weinig of geen financiële beloningen); expertsourcing (grote financiële beloningen) en gamesourcing (extreem grote geldbeloningen). Motivatieprofielen van optimaal presterende community leden per crowdsourcing type worden geïdentificeerd.

About the Author

Irma Borst received her Master's degree in Business Administration in 1992 at the Rotterdam School of Management. After her study, she worked over 15 years in management consultancy serving customers in the telecom, media and IT industry. Irma gained experience with business modeling, financial assessments and tariff calculations, analyses of financial risks, sensitivity analyses and valuations in the ICT sector.

From 2004 on, Irma participated in (inter)national research projects, e.g. 7th Framework project 'ECOLEAD' on virtual network organizations and Dutch B@home project on new broadband services. The contacts with universities established in these research projects resulted in a PhD research project which started in January 2007. The topic of the research project was described as open source business models in the multimedia domain, but evolved in time into research of crowdsourcing. Irma's PhD project is financed by NWO (Dutch Scientific Organization) as part of the 'Network of Networks' program and co-financed by Novay.

Her work has been presented at various international conferences including Academy of Management 2009 and International Product and Development Management Conferences 2007 and 2008. She also published in popular media including Automatiseringsgids and Emerce and was a frequent writer of columns at NUzakelijk.nl. In addition she presented her conclusions during the Dutch Innovation Seminar organised by De Baak.

Irma currently works as a principal consultant at Logica and as a researcher at Rotterdam School of Management, Erasmus University.

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Erasmus Research Institute of Management - ERIM

UNDERSTANDING CROWDSOURCING
EFFECTS OF MOTIVATION AND REWARDS ON PARTICIPATION AND PERFORMANCE IN VOLUNTARY ONLINE ACTIVITIES

Companies increasingly outsource activities to volunteers that they approach via an open call on the internet. The phenomenon is called 'crowdsourcing'. For an effective use of crowdsourcing it is important to understand what motivated these online volunteers and what is the influence of rewards. Therefore, this thesis examines the relationship between motivation and rewards on the participation and performance of online community members. We studied motivation, rewards and contributions in three crowdsourcing initiatives that varied in reward systems.

The findings of these three studies resulted in a refined model of the effects of rewards and motivation on voluntary behavior. With this model we provide a possible solution for contrary findings in empirical studies of online communities and the ongoing debate between two schools of cognitive psychology. Our results also have important implications for organizers of online communities, amongst others, regarding the effective application of reward systems. We also provide a crowdsourcing typology in which crowdsourcing initiatives are classified on the basis of their reward systems and identify the motivation profiles of optimal performers per crowdsourcing type.

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