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A Conceptual Framework to Define Incentive Mechanisms for Virtual Communities

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Abstract: Online incentive mechanisms constitute a strategy to stimulate members to participate and perform tasks in virtual communities. Given the diversity of variables and particularities that define virtual communities and their contexts, it is a challenge to identify and define incentives that are adequate to a given community. Our focus is on providing a systematic way to help designers to reason and develop their own analysis. We propose a conceptual framework to support the analysis of virtual communities, aiming to facilitate the definition of online incentive mechanisms. The framework is presented as a canvas with issues to be addressed through a set of questions, offering a visual and understandable guide. We evaluated the framework with a case study. We found that the framework satisfactorily supports designers in defining more complete and effective online incentive mechanisms.

Keywords: virtual communities, participation, incentive mechanisms, motivation.
Categories: L.6.1, L.6.2.

1 Introduction

Participation is, unsurprisingly, seen as a key aspect of virtual communities, since it contributes to community growth and sustainability [Bross et al., 2007], [Preece, 2000]. Typically, participation would be expected to correlate with community goals of one kind or another. The putative benefits are also contingent on community type, at least to a degree. Nevertheless, there is evidence that participation brings benefits. Members can retrieve and exchange information, music, video and other resources, discuss specialized contents, communicate and relate with others, and produce assets together, such as articles and software. In e-government initiatives, members are invited to participate by accessing information about public services, interacting with elected representatives, and by contributing in public venues [Harrison et al., 2011]. E-health communities enable members, who are patients acting as citizens or consumers, to engage in shaping, planning, and monitoring health services [Hesse et al., 2010].

A successful community must attract and keep enough members to make it worthwhile [Kim, 2000]. However, it is not a trivial matter. To obtain customers engagement is the greatest obstacle to success for a firm-sponsored virtual community [Porter et al., 2011]. Similarly, engagement and maintenance of participation are the two main issues in e-health communities [Goh and Agarwal, 2008]. The need to promote participation is also recognized as a strategic component to e-government communities [Picazo-Vela, 2011]. Goal attainment depends on the ability to develop and maintain communities through the provision of opportunity to participate and of motivation for it [Koh et al., 2007]. Such directive is based on the fact that participation cannot be forced, but rather can only be encouraged and facilitated [Chang and Chuang, 2011]. Participation maintenance and growth then depends on understanding peoples' reasons or motivations for participation, and providing them with effective means for doing so.

In order to stimulate participation in virtual communities, the use of online incentive mechanisms is often advocated. Complexities make the definition of incentive mechanisms a challenging activity. For instance, virtual communities (even with similar objectives) are social environments with specific contexts, so that what may fit to one community is not necessarily useful for another. Moreover, a community is populated by distinct kinds of members, who behave differently and have distinct expectations about the community [Cullen and Morse, 2011], [Lampe et al., 2010]. There is then the need to understand problem and context, to identify target audience, and to assess members' needs [Picazo-Vela, 2011]. Motivations may be of many kinds and, on top of this, contextually specific. To complicate matters, virtual communities evolve in response to members' interests and demands [Kim, 2000].

The competence building of designers with a better expertise regarding the definition of incentive mechanisms is then of interest. Designers here are people, with technical or management roles (for instance, software analysts, programmers, marketing professionals, and community stakeholders), who direct the development of the virtual community or who are responsible for the community creation and maintenance. However, nowadays, no systematic guideline is available to support designers to plan online incentive mechanisms. As we shall see, one of the main difficulties in providing some coherent view of participation is the sheer complexity of conceptual and theoretical devices used in explanation, magnified by the fact that different (and arguably incompatible) perspectives from psychology, social psychology and sociology are often deployed.

In this article, we then propose a conceptual framework for analysing virtual communities in order to define online incentives. We seek to identify a framework which would allow designers to think about the relevance of incentive mechanisms in distinct online contexts. The framework then draws on a wide literature and covers a range of themes. Our proposal is intended to be a systematization of the concepts and activities that may be involved in the definition of online incentive mechanisms. The framework is composed by activities that help to structure the design work by providing some assurance of completeness and consistency. Activities include the understanding of the community, the identification of groups of members to perform online tasks, the investigation of motivations, and the definition of incentive mechanisms. While the framework can be performed in one step, dividing it into discrete activities reduces the analytical burden on designers and provides a structured

way for defining online incentives. The framework is useful for both designing new communities and improving the attraction of members in existing communities. When the framework is used before the community has been created, it provides the information necessary to guide the designer. Defining incentives in the earliest conceptual phases is an interesting and effective way to provide attractive communities. The framework can also be applicable to communities already in operation in order to implement new mechanisms and/or improve existing ones.

The article is organized as follows. In Section 2, we describe briefly the background work for our research, including virtual communities, incentive mechanisms, and related work. The framework is presented in Section 3. In Section 4, we present the evaluation of the proposed framework based on a case study. In Section 5, we discuss our work addressing key factors and limitations. We also provide the theoretical and practical implications of the work. In Section 6, we present our conclusions.

2 Background

In this section, we present the research background. We provide an overview of virtual communities. We discuss incentive mechanisms, giving examples of incentives in both offline and online contexts. We also describe briefly the related work.

2.1 Virtual Communities

There is no widely accepted definition for the term 'community'. No consensus exists about the definition of virtual communities either, which in turn leads to substantial discussion around the conceptual foundations of virtual communities [Äkkinen, 2005], [Fuchs, 2006]. In fact, virtual community is difficult to define since it is a multi-disciplinary concept, so the definition depends on the perspective. Some perspectives include sociology, technology, business, and economics. Rheingold [Rheingold, 1993] defines virtual communities as social aggregations that emerge from the Net when enough people carry on those public discussions long enough, with sufficient human feeling, to form webs of personal relationships in the cyberspace. This initial definition already includes elements of sociology and psychology.

Preece [Preece, 2000] defines virtual community as a group of people, who come together for a purpose online, and who are governed by norms. Preece identifies four elements in a virtual community: shared purpose, people, norms and computer technologies. Shared purpose includes interest, need, information exchange, or service that provides a reason for the community. People are the individuals that interact socially as they strive to satisfy their own needs. Norms guide people's interaction, while computer technologies provide the support to interactions. The objectives, or shared purposes, of a community are intrinsic to it, so distinct objectives may lead to distinct communities. The characteristics of people, the range of purpose they pursue, the type of governance policies they develop, and the design of the software supporting a community, vary from community to community.

As in other works [Porter, 2004], [Souza and Preece, 2004], we adopt the definition of virtual community given by Preece [Preece, 2000] and assume that the term "virtual community" and "online community" are used interchangeably. In the next section we discuss the employment of incentive mechanisms, typology, and context in virtual communities.

2.2 Incentive Mechanisms

Employing incentives (or incentive mechanisms) is a strategy to influence and improve individual behaviour in a desired way, which in the context of our work would be the generation and maintenance of acceptable participative behaviour in online communities. Incentive mechanisms are already used in distinct contexts of offline groups, communities and organizations, for example, in the treatment of people with disorders, such as drug abuse [Wise, 2004] and autism [Fitzer and Sturmey, 2007]. Other examples of incentives are the educational campaigns and home visits employed in an urban slum for encouraging people to participate in the solid waste handling [Zurbrügg and Ahmed, 1999]. The provision of incentive mechanisms is also commonplace in a performance-related organizational context [Management Study Guide, 2012], which can consider monetary (e.g. salary, gifts) and non-monetary (e.g. job enrichment, promotion opportunity) incentives.

As mentioned, incentive mechanisms can be employed in virtual communities to stimulate participation in online tasks. For instance, Tedjamulia et al. [Tedjamulia et al., 2005] highlight three types of online incentives: financial (including monetary and other tangible rewards), performance appraisal (to inform members about the value of their participation), and social recognition (including attention, compliments, and praise). Non-monetary incentives, such as performance appraisal and social recognition, they suggest, can be extremely powerful as long as such incentives are public, infrequent, credible, and culturally meaningful. Janzik and Herstatt [Janzik and Herstatt, 2008] also investigate incentive mechanisms used in innovation virtual communities and organize them in the following categories: financial incentives (e.g. payment and premiums), indirect financial incentives (e.g. bonus and coupons), social incentives (e.g. peer recognition), and organizational incentives (e.g. additional rights and career progression).

In the specific context of firm-sponsored virtual communities, Porter et al. [Porter et al., 2011] illustrate some incentive mechanisms, including: encouraging content creation; cultivating connections among members and between members and community as a whole; and creating enjoyable experiences. A sponsor can encourage content creation by establishing a process in which members can rank or tag favoured content and make this content easy to locate. A sponsor can also initiate discussion-based events on topics that are relevant to members, for example offering webinars. Connections among members can be cultivated through storytelling and problem solving, where members ask a specific question to others in the form of a personal story or situation. Enjoyable experiences can be provided by giving members the ability to customize their experiences within the community.

Incentive mechanisms are, then, related to the stimulation of members' participation, by encouraging members to realize the benefits of new objectives and motives. So incentives in general first address motivations of the individual, and then their relationship to the larger community. In this sense, an online incentive

mechanism is something employable in a virtual community that is able to move members to participate online by acting on their motivations.

2.3 Related Work

The obvious consequences of poor participation levels – the loss of community popularity and sustainability – have led researchers to investigate different elements that affect members' participation. Some investigations consider the influence that characteristics of the community itself and its members can have on the members' participation in online tasks. For instance, Koh et al. [Koh et al., 2007] discuss the effect of IT infrastructure, offline interaction, and community size, on the posting and viewing activities in virtual communities. In other work, Ilgaz and Askar [Ilgaz and Askar, 2010] investigate the influence of demographic characteristics (such as age, gender and period of computer usage) on the sense of community in an e-learning community. Such investigations consider a defined set of elements that affect participation in a specific community of interest; however a general approach that elucidates key aspects to the definition of online incentives is still missing.

Research into motivation was conducted in various communities, for example e-learning [Jacob and Sam, 2010], knowledge sharing [Bross et al., 2007], [Chang and Chuang, 2011], open source software (OSS) development [Fang and Neufeld, 2009], [Xu et al., 2009], e-government [Airong and Xiang, 2008], games [Hsu and Lu, 2007], and wikis [Kuznetsov, 2006], [Nov, 2007], [Bezerra and Hirata, 2011b]. For instance, Fang and Neufeld [Fang and Neufeld, 2009] found that two main motivations, situated learning and identity construction, are related to sustained participation in OSS projects. While investigating motivations in a given community, some works address the relation between motivations and incentive mechanisms. For example, Chang and Chuang [Chang and Chuang, 2011] acknowledge that designers interested in developing and sustaining knowledge sharing in virtual communities should develop mechanisms that motivate members to participate in collective actions. These works concern about the identification of the main motivations that lead members to participate in an existent community; however no directive is provided regarding the definition of online incentive mechanisms.

Other research efforts are directed towards the proposal and evaluation of incentive mechanisms as a strategy to boost participation. For example, Porter et al. [Porter et al., 2011] discuss motivations and incentives in firm-sponsored virtual communities. Similar research, but in distinct community types, includes those made by Lan and Yan [Lan and Yan, 2009], and Gutierrez et al. [Gutierrez et al., 2011]. Kim [Kim, 2000] provides more general recommendations for building new communities, and discusses some incentive mechanisms, such as members' profile, leadership program, cyclic events, and rituals. Kraut and Resnick [Kraut and Resnick, 2008] synthesize and recommend design principles for encouraging members' contributions, for instance through performance feedback. Their design principles are general and do not consider particularities such as types of task, groups and motivations of a defined virtual community. Our proposal aims then to fill the lack of a systematic guidance about how to define incentive mechanisms for a given virtual community.

Zhang et al. [Zhang et al., 2012] consider the scenario of online groups with 10-12 members developing engineering education projects. In this case, knowledge

sharing is critical to accomplish innovative work. They investigate a model that includes economic incentive (i.e. to receive extrinsic rewards as points for sharing knowledge), social incentive (i.e. to be recognized by team due to shared knowledge), individual difference (focused on exchanged ideology), explicit knowledge sharing (i.e. knowledge that can be readily articulated or codified), and tacit knowledge sharing (e.g. beliefs, viewpoints, and expertise). They found that economic incentive positively affected members' explicit knowledge sharing, while social incentive positively affected tacit knowledge contribution. They also found that members with strong individual difference have limited or no contributions in the presence of economic incentive.

Zhang et al. [Zhang et al., 2012] concern specifically to online teams and engineering education projects. Our approach focuses on online communities, but it can be also applied to online teams. The main characteristics of online teams to be considered are the quantity of members, and the short-term duration of the developed tasks. Zhang et al. [Zhang et al., 2012] are interested in discovering the effect of two kinds of incentives (economic and social) in two types of tasks (explicit and tacit knowledge sharing), and how such effect is moderated by individual differences. They found important results (learned lessons) that can support designers when defining incentives in the specific context that they investigated. We provide a general guideline, not restricted to a specific context or community. Using our framework, designers are stimulated to think about context specificities, and then to have more foundations to propose incentive mechanisms. Zhang et al. [Zhang et al., 2012] commented that incentives can affect task participation in different ways. It is according to our proposal, where we suggest reflections about tasks before proposing incentives. They also discuss the relevance of individual differences on incentives' effect. Such a relevance is considered in our framework, when we indicate that members' characteristics and motivations shall be evaluated in order to define more appropriated incentives for distinct publics.

Zhang et al. [Zhang et al., 2013] concern about how to encourage employees to share their knowledge with others in order to foster online knowledge sharing (KS) in organizations. They explain the potential of organization reward (e.g. improved pay, conditions, and benefits) to act as a mechanism to incentive knowledge sharing. The effectiveness of the incentive mechanism depends on other aspects (called moderating factors), so they propose and validate a conceptual model of three-way interaction consisting of organizational reward, knowledge sharing visibility, and exchange ideology. Knowledge sharing visibility (KSV) is defined as "the extent to which employees' KS behavior can be identified and monitored by other participants (e.g. their supervisors and peer knowledge reviewers)". Exchange ideology (EI) means "the strength of an employee's belief that work effort should depend on treatment by the organization". They found that organization reward can be ineffective in case of low KSV, regardless EI level. They also found that employees with high KSV perception can be motivated by the organization reward; in this case, with better results when EI is high.

Zhang et al. [Zhang et al., 2013] focus on a specific context: the community is the organization itself, the task is knowledge sharing, and the members are the employees. They investigate in which conditions a specific incentive mechanism (the organization reward) can booster members' participation. In our approach, we do not

consider a specific context. Instead, we provide a general guideline to aid designers to understand the context and to be able to define incentive mechanisms according to the context. We underline the importance of aspects related to individuals, such as demographic and cognitive characteristics, due to their influence on how individuals perceive the incentives. Zhang et al. [Zhang et al., 2013] corroborate our proposal when consider EI as an individual difference aspect. We also explain the relevance of understanding task characteristics (for instance, objective and subject) in a way to define proper incentives. Considering KSV, Zhang et al. [Zhang et al., 2013] explain the way the task is performed: the task is up to revision by other people. KSV is then a specific task characteristic that can moderate the influence of the incentive on members' motivation (such as esteem and reputation). It is then an example of what our approach points out as important when defining incentives. Zhang et al. [Zhang et al., 2013] also suggest that organizations should provide distinct incentives trying to favor different individuals to share knowledge. Our approach can help in this trend, by guiding designers through investigations of individuals and their motivations.

3 A Conceptual Framework to Define Online Incentive Mechanisms

The framework, we propose, aims to guide designers to know and understand the community reality, in order to be able to identify and suggest incentive mechanisms aligned to that reality. The framework leads designers through an investigation of the virtual community under study and its online tasks (activity: "1. Understanding the Virtual Community"). Once the online tasks are identified and understood, the framework guides designers to a better understanding of the members involved in such tasks (activity 2: "Identification of Groups to Perform Tasks"). Afterwards, the factors related to motivation of these members are analyzed (activity 3: "Analysis of Groups to Perform Tasks"). Based on the identified motivating factors, the framework explains how designers can define and analyze incentive mechanisms (activity 4: "Definition of Incentive Mechanisms"). The proposed activities are suggested in a sequence that represents the main flow of the framework, although there may well be feedback. In order to improve designers work, the framework is presented based on a canvas (Figure 1), as well as questions (Table 1) to aid the canvas filling.

3.1 "Understanding the Virtual Community" Activity

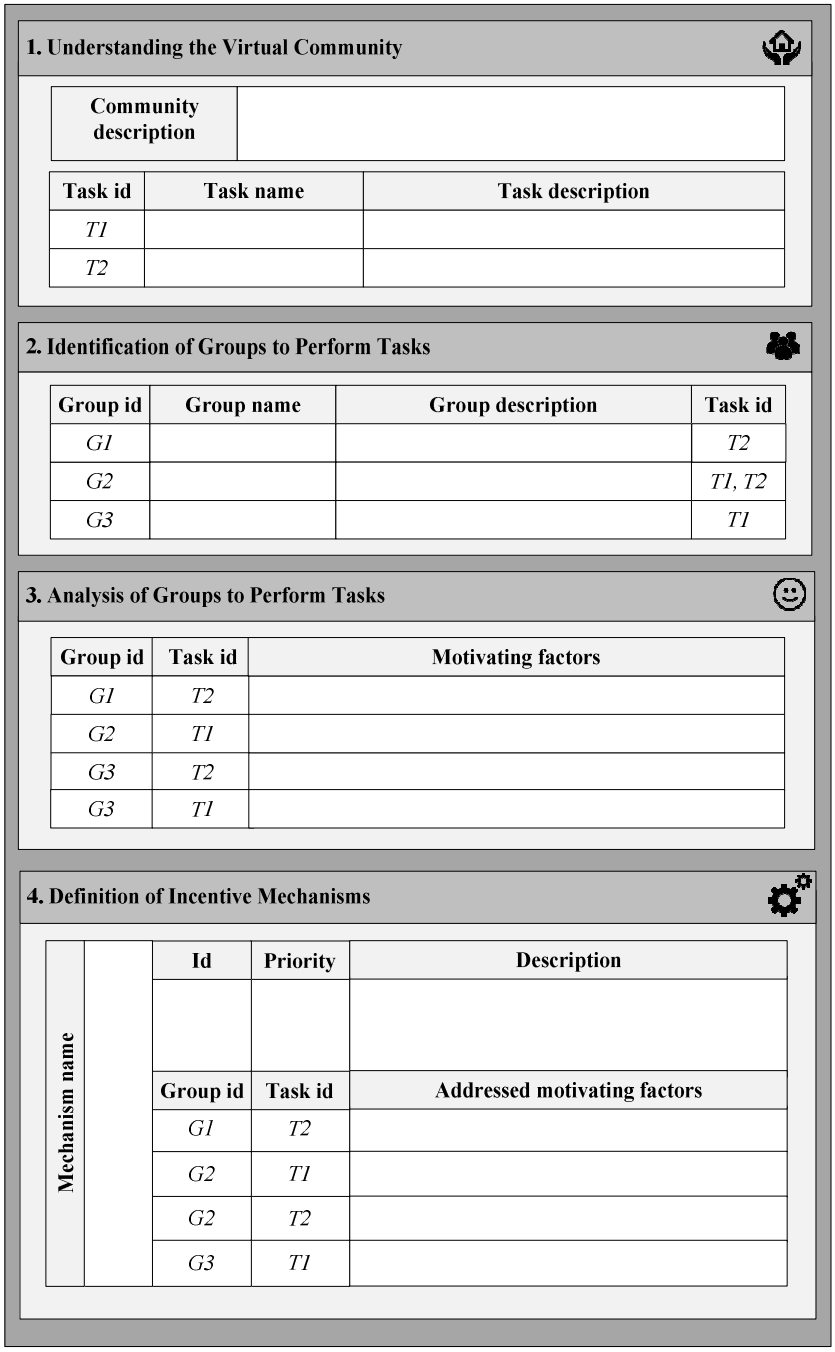
Understanding the virtual community can be made, we argue, through the investigation of its goal (question 1.1 in Table 1) and main characteristics (question 1.2). According to the proposed canvas (Figure 1), information related to community can be added in the "Community description" field. In this manner, we aim to distinguish the community under study from others. In order to understand the specifics of a given community, we suggest the following attributes: *establishment*, *orientation*, s*ize, self-organization*, and *volunteering.*

Establishment aims to identify if the virtual community is member-initiated or organization-sponsored [Porter, 2004]. In case of organization-sponsored or profit-driven communities, there may be some urgency for participation in order to generate return on investment promptly. Communities with distinct *orientations* comprise

members with different profiles, purposes, and motivations. For example, in e-health community, personal orientation includes individual citizens concerned to their own health and their loved ones; while clinical orientation is made up of practitioners and biomedical scientists collaborating on diagnosis [Hesse et al., 2010]. Community *size* is an attribute that impose different challenges for encouraging online participation. For instance, in e-government communities, participation in small-scale projects was found to be relatively successful, whereas participation in large-scale projects faces more challenges to succeed [Oostveen and Van Den Besselaar, 2004]. *Self-organizing* virtual communities are not controlled by an elite group, but by self-managed networks of activists [Fuchs, 2006]. In this way, they are more flexible, which can stimulate participation and involvement of members [Crowston et al., 2007]. Communities based on *volunteering* can have increased participation problems due to the absence of factors that keep volunteers engaged.

Other important aspect to understand the online community is to identify and understand community tasks (respectively questions 1.3 and 1.4 in Table 1), since a community goal can be said to be attained when community members work effectively on community tasks. Tasks in virtual communities vary in nature and size. For example, one task can be to elaborate an article as in Wikipedia. However, tasks can be decomposed. The previous task can be considered as two separated tasks: to write an article, and to revise an article. Designers should define tasks with a granularity that allows them to proceed with further analysis of members involved and planning of incentive mechanisms. Information regarding the identified tasks (id, name and description) can be included in the canvas (Figure 1). In the canvas, we suppose the existence of two tasks (*T1* and *T2*), as example. In order to help tasks' characterization, some attributes are useful: *objective*, *level*, and *subject*.

Tasks have distinct *objectives*, with different consequences for motivation. For example, in discussion communities, 'viewing' activity is associated with the perception of community usefulness, while 'posting' activity is influenced by offline interaction and the quality of the IT infrastructure [Koh et al., 2007]. A task can, further, be of distinct *levels*, for instance operational, procedural and normative. The importance of classifying the task according to its level is to both better characterize the task and later be able to understand the public interested in the task. For instance, the population involved in normative tasks in Wikipedia is in general members that actively contribute to the operational activities in the community and have already developed the sense of ownership of the community [Bezerra and Hirata, 2011a]. A task can refer to distinct *subjects*, which can, again, affect willingness to participate, depending on familiarity and specialized knowledge. In e-government communities, for example, the complexity of particular subjects debated can exclude a large part of the population, since people lose interest in themes that they are unable to relate to their own context [Mantilla, 2009].



1. Understanding the Virtual Community

Community description	

Task id	Task name	Task description
T1		
T2		

2. Identification of Groups to Perform Tasks

Group id	Group name	Group description	Task id
G1			*T2*
G2			*T1, T2*
G3			*T1*

3. Analysis of Groups to Perform Tasks

Group id	Task id	Motivating factors
G1	*T2*	
G2	*T1*	
G3	*T2*	
G3	*T1*	

4. Definition of Incentive Mechanisms

Mechanism name		Id	Priority	Description
		Group id	**Task id**	**Addressed motivating factors**
		G1	*T2*	
		G2	*T1*	
		G2	*T2*	
		G3	*T1*	

Figure 1: Canvas for defining incentive mechanisms

Activity	Key questions
1. Understanding the virtual community	1.1. What is the community goal? 1.2. Which are the community characteristics? E.g. establishment, orientation, size, self-organization, and volunteering. 1.3. What are the online tasks? 1.4. Which are the characteristics of the online tasks? E.g. objective, level, and subject.
2. Identification of Groups to Perform Tasks	2.1. Which groups of members can be identified to perform the online tasks? 2.2. Which are the characteristics of the groups? E.g. demographic aspects, cognitive aspects, organizational structure, social ties, and membership trajectories.
3. Analysis of Groups to Perform Tasks	3.1. Given a pair of group and task previously identified, which motivations could move the group towards participating in the task? E.g. acceptance, positive distinctness, entertainment, prestige, reputation, social loafing, power, competence, curiosity, career, progress evaluation, and idealism.
4. Definition of Incentive Mechanisms	4.1. How does the mechanism work? 4.2. Given a pair of group and task, which motivating factors are addressed by the mechanism? 4.3. Is the mechanism compliant with community, including aspects of community scenario, tasks, members, and motivating factors? 4.4. How is the mechanism evaluated in terms of implementation effort? 4.5. How is the mechanism evaluated in terms of maintenance effort? 4.6. How is the mechanism evaluated in terms of secondary effects? E.g. “gaming of the system” and conflicts. 4.7. Which is the mechanism priority? 4.8. Are all the motivating factors previously identified addressed?

Table 1: Key questions for defining incentive mechanisms

3.2 "Identification of Groups to Perform Tasks" Activity

Given an online task, it is desirable to determine who is involved in performing such a task (question 2.1 in Table 1). One or more groups of members can be involved in a single task. Members with distinct characteristics (question 2.2), in general, have different requirements and expectations, so that they are moved by distinct motivations, and consequently specific incentives should be defined. A table is proposed in the canvas (Figure 1) to gather information about groups of members, including id, name, description and related tasks. In the canvas, as example, we suppose the existence of three groups (*G1*, *G2*, and *G3*) and associated them to existent tasks (*T1* and *T2*). For instance, group *G1* is expected to participate in task *T2*; while group *G2* could contribute to tasks *T1* and *T2*.

Through the community purpose it is possible to infer the general target audience of the community. For instance, in e-government communities, different groups of members can take part such as citizens, decision makers, and bureaucrats [Harrison et al., 2011]. Sometimes, especially in open and large communities, there is no well defined audience, so designers can infer groups with some general features. However, designers should be aware that the identification of groups can be overly simplistic. Simplified classification can fail to consider individuals' differences. Moreover, invalid assumptions and false stereotypes can disrupt the real essence of the individuals in the group [Miaskiewicz and Kozar, 2011]. These problems can be mitigated with a proper involvement of community members or potential members during the design process.

In order to support the understanding of members (or groups of members), attributes are useful, for instance: *demographic aspects*, *cognitive aspects*, *organizational structure*, *social ties*, and *membership trajectories*. *Demographic aspects* include characteristics as age, sex, ethnicity, education, and function. According to Koh et al. [Koh et al., 2007], heterogeneous virtual communities in terms of age, education, and profession challenge designers to reach a consensus about common goals and interests, and consequently to explore and deal with members' needs. *Cognitive aspects* reflect differences in beliefs and preferences of group members about group goal. For instance, Cullen and Morse [Cullen and Morse, 2011] discuss how personality traits (e.g. agreeableness and neuroticism) affect participation levels in online communities. The differences in demographics and cognitive aspects lead to differences in motivation to participate, and consequently affect the design of incentive mechanisms.

Organizational structure is an important attribute in a group. Wallace [Wallace, 1997] argues that flat structures in formal organizations are usually successful because they inherently encourage members to share information. Hierarchical structures, in contrast, can impel members to compete for information as a way to move up in hierarchy. Some virtual communities exist purely in cyberspace. However, there are other communities where members' interactions happen offline as well, and so type and degree of *social ties* are relevant. For instance, Burke et al. [Burke et al., 2009] comment that new users in a community are more stimulated to share information when members to whom they have social ties are already collaborating. Depending on the degree of involvement of members in a community, they can be classified in distinct *membership trajectories*, for example: peripheral, inbound, insider, boundary and outbound [Wenger, 1999]. According to Lampe et al.

[Lampe et al., 2010], to stimulate the participation of long-term members may be more difficult due to the variety of motivations to consider, so that it could require different techniques or incentives.

After identifying and understanding distinct groups in a virtual community, the next step is then to analyze their motivations to participate.

3.3 "Analysis of Groups to Perform Tasks" Activity

Once the groups of members involved in the online tasks are identified, we aim to identify factors related to the motivation of such groups (question 3.1 in Table 1). Some theories derived from organizational, psychological, and sociological studies can be seen as appropriate for understanding online motivations, though it is doubtful whether any single theory can encompass all factors of all social behaviour. In the canvas (Figure 1), there is a table to add motivating factors for each pair group-task previously identified. As example, we add in the canvas the pairs suggested in the previous activity.

Aiming to guide the activity execution, we provide hereafter general motivating factors in virtual communities. Maslow [Maslow, 1987] proposes the Hierarchy of Needs, which is sometimes regarded as useful for such psychological considerations. Kim [Kim, 2000], for instance, brings the hierarchy of needs to the online context. However, it is not clear that Maslow's hierarchy is in fact a hierarchy of motives at all, and nor is it clear that such motives are always intrinsic. Such a hierarchy is preserved here for heuristic reasons, including the following needs: *physiological*, *safety*, *belonging*, *esteem* and *self*-actualization.

Physiological need is related to system access, and the ability to participate online. *Safety* need, discussed together with the concept of security, refers basically to protection from hacking. We argue that these needs refer to provide a suitable environment to support the community by addressing issues related mainly to the system as well as the norms that govern members' activities. System issues as usability [Lampe et al., 2010], [Michaelides and Morton, 2008], security [Lampe et al., 2010], [Michaelides and Morton, 2008], reliability [Picazo-Vela, 2011], performance, and awareness [Airong and Xiang, 2008], [Lan and Yan, 2009] can interfere on members' motivation. Similar concern occurs regarding norms' issues, such as: availability [Lampe et al., 2010], clearness [Lampe et al., 2010], adaptability [Pascale et al., 2001], and enforcement [Airong and Xiang, 2008], [Bezerra and Hirata, 2010]. To deal with factors related to norms and system is critical, however, we argue that they play the role of maintenance or hygienic factors [Herzberg et al., 1959]. The presence of hygienic factors is not stimulating, but their absence can reduce motivation. So, in the "Analysis of Groups to Perform Tasks" activity, we assume that such factors are properly addressed. We then focus on *belonging*, *esteem* and *self-actualization* needs.

Belonging refers to the desire of social interaction or socialization in situations where one feels accepted. In this category, we identify some factors, such as: social interaction, acceptance, social exchange, identification, positive distinctiveness, uncertainty reduction, optimal distinctiveness, and entertainment. Social interaction is the desire for peer companionship and awareness of others [Hersey et al., 2000], being related to socialization [Reiss, 2004], and interpersonal connectivity [Dholokia et al., 2004]. Acceptance refers to the desire for approval [Hersey et al., 2000], [Reiss,

2004] and it is related to self-confidence [Reiss, 2004]. Social exchange is the desire to exchange resources [Molm, 2006], being related to self-discovery [Dholokia et al., 2004], and protective [Clary et al., 1998]. Identification includes the shared values with community and members [Ren et al., 2008], [Hogg, 2006], being related to commitment [Molm, 2006], [Ren et al., 2008]. Positive distinctiveness is the belief that "we" are better than "them" [Hogg, 2006]. Uncertainty reduction refers to the desire to reduce the subjective uncertainty about the group operation [Hogg, 2006]. Optimal distinctiveness is the desire to balance inclusiveness (satisfied by group membership) and distinctness (satisfied by individuality) [Hogg, 2006]. Entertainment is the desire for fun, relaxation, or creative pleasure [Dholokia et al., 2004].

Esteem refers to the need to be recognized by others due to participation. Esteem is manifested through factors as: prestige, appreciation, social status, social loafing, power, and responsibility. Prestige is the desire for social standing, reputation, and visibility [Hersey et al., 2000], being related to social enhancement [Dholokia et al., 2004], [Clary et al., 1998]. Appreciation refers to the desire for gratitude or thankful recognition [Hersey et al., 2000]. Social status is the honour attached to one's position in a group [Reiss, 2004], being related to success [Hersey et al., 2000]. Social loafing is the belief that contributions are unique [Karau and Williams, 1993]. Power refers to the desire to influence and mastery, being related to trust and respect [Hersey et al., 2000]. Responsibility is the desire to be in charge or to take care of something, being related to leadership [Reiss, 2004].

Self-actualization is the need to maximize own potential, by developing skills and opening up new opportunities. Self-actualization includes factors as: competence, curiosity, career, challenging, personal realization, progress evaluation, comparison with others, and idealism. Competence is the desire for skills and knowledge [Hersey et al., 2000], being related to learning [Hersey et al., 2000] and understanding [Clary et al., 1998]. Curiosity refers to the desire to know or explore things [Reiss, 2004]. Career is the desire for professional growth [Hersey et al., 2000]. Challenging refers to the desire for new opportunities, being related to risk assumption [Hersey et al., 2000]. Personal realization is the desire to accomplish something considered important [Hersey et al., 2000]. Progress evaluation is the desire to evaluate achievements [Hersey et al., 2000]. Comparison with others refers to the desire to position your progress among other [Hersey et al., 2000], being related to vengeance, competition, and winning [Reiss, 2004]. Idealism is the desire to improve society, being related to morality, altruism, social justice [Reiss, 2004], and values [Clary et al., 1998].

The theories, we discussed, can be used by designers as a guideline to identify motivating factors for the groups of members. For each different community or group, of course, different factors will have relative importance. Even so, these characteristics should relate to design decisions.

3.4 "Definition of Incentive Mechanisms" Activity

All information generated in the previous activities may be relevant to the actual provision of incentive mechanisms, including: community attributes, identified tasks, groups of members, and motivating factors. Incentive mechanisms shall be defined to address factors that influence motivation of a group (or groups) to perform a task (or tasks) in community. A factor can be handled by more than one incentive mechanism,

and a single incentive mechanism can address more than one factor. The detailed specification of how an incentive mechanism works (question 4.1 in Table 1) can be added in the "Mechanism description" field in the canvas (Figure 1). There are also fields to add mechanism id and name. We provide a table to designers define the motivating factors addressed by the mechanism for each pair group-task. The table is similar to what was proposed in the previous activity, however here designers should fill the table only with the motivating factors previously identified.

Besides identifying an incentive mechanism, it is critical to analyze its suitability. In this way, distinct criteria can be used. The main criterion is compliance with the community, including all the aspects of community scenario, tasks, members and motivations already identified (question 4.3). For example, a mechanism that allows a member to invite any friend to the community is not suitable to private communities inside organizations. Implementation effort is a further consideration (question 4.4). Complex mechanisms lead to more demanding implementation, and consequently they require longer delivery time. One concern about the implementation effort, especially in communities supported by open-source platforms, is the reliability of the available extensions, since some extensions miss a large scale verification, which can restrict the mechanism performance. In addition, maintenance efforts need to be considered, especially as they relate to community norms (question 4.5). A mechanism that requires new complementary activities and roles should concern about both how to implement them and who performs them.

Other criterion to analyze the suitability of a mechanism proposal is to reason about possible secondary effects, such as "gaming of the system" and conflicts. Not handling these issues impacts directly the maintenance of the mechanism, since complementary activities can be necessary to guarantee its correct operation. The MediaWiki ReaderFeedback extension is an example of mechanism that overcomes a possible "gaming of the system". In this mechanism, readers can evaluate the quality of an article in a wiki community supported by MediaWiki platform. "Gaming of the system" can occur if a member votes many times and disrupts the article assessment according to his/her own desire. To avoid this undesired behaviour, the ReaderFeedback mechanism allows only one evaluation per member, which can be later updated by the member. "Gaming the system" was found to be more common with mechanisms that reward task-contingency but not performance-contingency [Kraut and Resnick, 2008].

The generation of conflicts is other possible secondary effect of an incentive mechanism. Conflicts affect motivation and can result in low participation. In e-government communities, for instance, high quantities of participation can disturb activity execution by capturing disjointed views (conflicts) and delaying the activity closure [Harrison et al., 2011]. Status, esteem and reputational matters seem to relate to conflict, for example in the Wikipedia, conflicts can occur due to divergences between editors and administrators over article contents [Bezerra and Hirata, 2011c]. Moreover, performance feedback, and especially comparative performance feedback, can generate an undesirable competitive environment in the community [Kraut and Resnick, 2008]. However, conflicts are not always undesirable. They can be beneficial by contributing to creativity, innovation, and improved decision-making. For instance, Campbell et al. [Campbell et al., 2009] discuss how conflicts become more than just dysfunctional communication and can help to motivate and unify

members by aligning values and ideals among positions of power. What these possibilities indicate is that we must be aware about the secondary effects generated by the proposed mechanisms.

The information driven from the analysis of an incentive mechanism can be used to improve the mechanism specification if any inconsistence or undesirable issue is identified. In this case, the analysis process can be performed in a spiral way of enhancements. Designers can face the problem of choosing which mechanisms to implement in community, given the diversity of identified mechanisms. In this case, it is useful to prioritize mechanisms (question 4.7). The priority of a mechanism can be a function of impact and effort. Impact is the estimation of the gain of employing the mechanism, considering its potential effectiveness in stimulating participation. Effort is driven from the analysis of both implementation and maintenance cost. After proposing all incentive mechanisms, a final verification is required to guarantee that all identified motivations are being handled by the defined incentive mechanisms (question 4.8). If not, improvements can be made in defined mechanisms, or even new mechanism can be proposed.

4 Evaluation of the Conceptual Framework to Define Online Incentive Mechanisms

The evaluation of the proposed framework is not a straightforward task. A concern is the demanding nature of the identification and analysis of online incentives, which require a deep involvement of designers. Good results are expected to be reached not just because of the framework; but due to the proper usage of the framework by designers who put analysis effort on it. This fact generates a difficulty in the framework evaluation, which is the recruiting of designers. Such difficult, in turn, impair statistical evaluations. Statistical evaluations with many teams of designers are not feasible due to high cost. Therefore we focus on the qualitative evaluation of the framework.

It could be interesting to focus on the designer's perspective on the putative benefits of the framework in comparison to other existent guideline. However, as far as we know, our proposal is the first in this trend of defining online incentives. We could then compare designers' perspective in two situations: when working without the framework, and later with the framework. This strategy could be questioned due to a possible lack of control for learning effect, since better results in the second situation could be justified not by the use of the framework, but just for practicing twice the same analysis. Even with a different community in both situations, the learning effect would remain. Moreover, to compare designs of distinct communities would be impractical, due to the lack of common aspects to be evaluated. Other evaluation strategy could be to invert the two situations: designers should work with the framework firstly, and later without the framework. In this case, the second situation would be corrupted by the nature absorption of the framework directives during the first situation.

We opted to evaluate the incentive mechanisms resulted of two analyses considering the same virtual community context: the first analysis is made by a pair of designers without the framework, and the second analysis is made by other pair of

designers supported by the framework. To implement the incentives suggested in each analysis in different systems would add the possibility to investigate the quality of defined incentives. However, this approach faces the challenge of dividing the virtual community and keeping it separated during the investigation. It could generate confusion to members, besides no consolidate environment would be provided to favour the community. We then decided to elaborate only one system with the incentives driven by the analysis with the framework. It allowed us to reason about members' satisfaction with both the community and the way it was implemented considering the online incentives. The study effort was roughly divided into 8 months.

4.1 Experiment design

We invited four researchers interested in the Collaborative Systems area to participate as community designers. We refer to them as R1, R2, R3, and R4. R1 is male of 24 years, and he has 2 years of experience with software design. R2 is a female of 23 years; she reported to have good experience with software development mainly related to Web and Business Intelligence systems. R3 is a male of 20 years; he reported experience with C program and Android applications. R4 is a male of 51 years; he assessed himself as expert in ERP (Enterprise Resource Planning) systems. For all participants, we explained the concept of incentive mechanism and provided some examples, in order to guarantee a common understanding about incentives. We explained the community scenario in a face-to-face meeting and also provided a written description.

The scenario is a demand by the undergraduate student union (named CASD) of an engineering school (here, referred to as the institute). The institute is nowadays composed by approximately 150 faculty members and 600 undergraduate students. There exists an academic and professional ethical code at the institute, known by the acronym DC (Conscious Discipline) with the following key values: honesty, fairness, and transparency. An important role of CASD is to present, disseminate and enforce the code among all undergraduate students with the support of the institute. However, the lack of formalization of the code and availability of students, faculty, and staff makes effort in this direction difficult. CASD and some faculty members hypothesize that a virtual community might help with these goals. The virtual community is a virtual place where members can debate the code, discussing its application and exemplifying with real cases. Such an environment would help to strength the code in the institute. Two developers, called here D1 and D2, were responsible for the initial implementation of the system in Month 1 using the Wordpress platform. They were undergraduate students and their participation was part of their final project in a Computer Engineering Course. The virtual community is composed of a wiki and a forum. In the wiki, members can read and write articles about the code. The forum allows members to discuss issues related to the code.

We showed to all designers a prototype of the system to support the virtual community. We divided designers in two groups randomly. Group A, composed of R1 and R2, was required to define incentive mechanisms for the given virtual community without reference to or knowledge of the proposed framework. Group B, composed by R3 and R4, was required to design incentives using the framework. The design phase was accomplished by both groups in Months 2 and 3. After that, they individually reported their experiences in a questionnaire (Table 2), aiming to verify if

the framework adequately supports a virtual community designer in defining online incentive mechanisms.

Evaluation issue	Questionnaire
The framework helps designers to define incentive mechanisms that address the community goal.	Did you analyze participation in different tasks? Did you consider community members as a unique group? Did you deal with the differences between groups of members?
The framework helps designers to define incentive mechanisms that address members' motivation.	Which foundation did you use when defining incentives? How did you think incentives would stimulate members? Did you considered members' motivations to participate? Didi you interview members to assess their motivations?
The framework leads to an accurate definition of incentive mechanisms.	Which aspects did you use to analyze the design of incentives? Did you analyze incentives' compliance with the community ? Did you analyze incentives regarding implementation effort, maintenance effort, possible negative effects? Which aspects did you consider to prioritize the incentives?
The framework description is adequate.	Is the framework clear? Is the framework sufficient? Is the framework instructive? Is the framework demanding (in terms of effort)? Note: Questions made only to designers who used the framework

Table 2: Questionnaire to evaluate framework adequacy in supporting virtual community designers

The incentive mechanisms established by group B (with the framework) were implemented in the community system by developers D1 and D2. Nearly all incentives were implemented, though some with low priority (according to the design) were discarded. All the development was made in Months 4 to 6. The community was then launched and we analyzed its operation during Months 7 and 8. A satisfaction survey was submitted to registered members after one month of community operation. It considered statements to be evaluated using a five point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The statements were: i) the virtual community is important to the institution; ii) the virtual community is needed by the institution; iii) I am satisfied with the virtual community;

iv) I am satisfied with the system that supports the virtual community; v) The virtual community reached its goal as it was implemented.

4.2 Experiment results and analysis

Group A (composed of designers R1 and R2 who worked without the framework) defined 6 incentives for the community. Group B defined 37 incentives. From the second set, we selected 27 incentives with higher priority for the community implementation, according to the analysis established by group B. Comparing both sets, we observed that the first set is included in the second. It suggests that, supported by the process, designers were able to explore the community scenario and the possibilities of incentives more completely. Figures 2 and 3 exemplify the usage of the framework by group B. In Figure 1, we have the entire analysis of the community, members and motivations. In Figure 3, we present the definition of two incentive mechanisms as example. Such mechanisms aim to motivate groups to participate in distinct tasks by dealing with different motivations.

According to the feedback provided by designers using the questionnaire (Table 2), we were able to reason about the benefits of using the framework. Group A reported that they had thought about incentives for the wiki and forum, but without identifying individual tasks. They made no attempt, for instance, to distinguish incentives for writing an article and reading an article on the wiki. As shown in Figure 2, group B decided to focus on four tasks: “to read an article”, “to write or edit an article”, “to read a topic and related answers in forum” and “to create a topic or answer in forum”. Designer R4 commented that other tasks could be considered, but that would make the analysis even more elaborated due to the high number of tasks. Group B commented that the process of investigating tasks and groups of members separately forced them to address the motivations of these groups and the possible dependencies between incentives. When asked if designers consider members as a unique entity in community, group A explained that they thought only about undergraduate students. Group B recognized that it is relevant to identify groups of members, in this case, undergraduate students and faculty members. Designer R4 explained that members were different in age, background and objectives, so they could react differently to a given incentive.

We asked designers which foundation they used to propose incentives. Group A explained that they relied mainly on their own experience to select incentive mechanisms. Group A also reported that they did not identify incentives based on motivations, but recognized in principle that there can be a relation. They did not conduct interviews with members and specified incentives based on discussions between themselves. Group B identified motivating factors of members in order to propose incentives. Designer R3 commented that the process drove him to better understand different motivations that a member may have. He added that the motivating factors were not only used to conceive a mechanism, but also to analyze its relevance. Designer R4 reported that group B conducted interviews with members in order to capture their perspectives and motivations.

1. Understanding the Virtual Community

Community description	Initiated by members; no profitable; social orientation; long-term duration; based on volunteering; middle size.

Task id	**Task name**	**Task description**
T1	To read an article	Operational task. It refers to the reading of articles about the code, aiming a better understanding of the code.
T2	To write or edit an article	Operational task. It refers to the writting or improving of articles about the code, aiming to the provide a common base of knowledge about the code.
T3	To read a topic and related answers in forum	Operational task. It refers to the reading of topics ans anwers in forum, aiming to know distinst views about a specific issue related to the code.
T4	To create a topic or answer in forum	Operational task. It refers to the creation of a new topic of interest related to the code, in order to retrieve community feedback. It also refers to the creation of an answer in forum, aiming to give a personal opinion about an issue.

2. Identification of Groups to Perform Tasks

Group id	**Group name**	**Group description**	**Task id**
G1	Undergraduate students	Engineering students; ages from 18 to 26; male in majority; common dorms; strength social ties; from distinct cities in the country.	*T1, T2, T3 and T4*
G2	Faculty members	High education level (master and phd); ages from 35 to 70; male in majority; some of them were students in the same institute.	*T1, T2 and T4*

3. Analysis of Groups to Perform Tasks

Group id	**Task id**	**Motivating factors**
G1	*T1*	Social interaction, social exchange, idealism, curiosity
G1	*T2*	Prestige, competence, progress evaluation, challenging
G1	*T3*	Social interaction, social exchange, curiosity
G1	*T4*	Prestige, optimal distinctness, social loafing, responsibility, competence, personal realization
G2	*T1*	Social exchange, idealism
G2	*T2*	Appreciation, idealism
G2	*T4*	Social loafing, responsibility, idealism

Figure 2: Assessment of community, members and motivations using the framework

4. Definition of Incentive Mechanisms

Mechanism name	Id	Priority	Description
To allow users to evaluate the quality of wiki articles	B1	6	To have a scale with zero to five stars for each article. Users can provide feedback about the article quality using such stars. Only one assessment is allowed per user, however it can be updated at any time.
	Group id	**Task id**	**Addressed motivating factors**
	G1	*T1*	Social interaction, social exchange, idealism
	G1	*T2*	Prestige, competence, progress evaluation
	G2	*T1*	Social exchange, idealism
	G2	*T2*	Appreciation

Mechanism name	Id	Priority	Description
To allow users to invite other users to contribute in forum	B17	4	Given a topic in forum, an user can select other users and invite him/her to contribute. The invited user will receive an email requesting his/ her participation in that topic.
	Group id	**Task id**	**Addressed motivating factors**
	G1	*T3*	Social interaction, social exchange
	G1	*T4*	Prestige, optimal distinctness, social loafing, responsibility, competence
	G2	*T1*	Social loafing, responsibility

Figure 3: Definition of incentive mechanisms using the framework

Regarding the 'correct' definition of an incentive mechanism, designer R2 reported that she did not conduct such analysis. Designer R1 explained that it was not necessary to investigate compliance with the community characteristics, since the community is similar to other existing communities known to him. Group A reported that they did not consider other aspects such as implementation effort, maintenance effort, and possible secondary effects. In group B, designer R4 recognized that the framework was essential to conduct the analysis of incentives. Designer R3 explained that the analysis of maintenance effort made his group to discard mechanisms that would require administrators to work on additional tasks to make the mechanisms functional. Group B reported that they identified cases of "gaming of the system" in

three mechanisms, so they decided to improve mechanisms' specification. Designer R4 also commented that they used two main questions to drive the analysis of secondary effects, as follows: "Is there any group that can react to this mechanism in an unexpected or undesired way?" and "Is there any way of changing this mechanism to get rid of the identified issue?". We felt on the basis of this data that group B had conducted a deeper analysis, one which was not present in group A.

Group B gave also feedback about the characteristics of the proposed framework, including clarity, sufficiency, instructiveness, and demanding in terms of effort. Designer R4 reported that the framework has a well defined structure. Designer R3 added that the framework activities are intuitive and coherent, which makes them understandable and easy to apply. Designer R4 explained that the framework seems sufficient since each part is well explained and it has examples to support both general and specific comprehension. Designer R4 also commented on framework instructiveness, explaining that the framework allowed him to reason about collaborative systems in a deeper and more analytic way. He added that the acquired knowledge would help him in other projects he is conducting. Designer R4 considered the framework demanding in overhead, since it requires effort to analyze various aspects; however he posed that the effort is mainly related to the scenario size. Designer R3 suggested that designers can plan their own effort depending on the scenario under study. This gave us confidence that the framework description is adequate.

To explore members' satisfaction, we sent a survey to the 73 registered members, and received feedback from 22. The results were: 95.4% agreed that the community is important to the institution; 81.8% reported that the community is needed by the institution; 86.4% were satisfied with the community; 100% said they were satisfied with the system that supports the community; and 81.8% agreed that the community objective was accomplished by the way it was implemented. The results show that members are satisfied with the community and the way the system was designed considering the incentive mechanisms.

5 Discussion

In this section we discuss the key findings related to both the proposal and evaluation of the framework for defining incentive mechanisms in virtual communities. We also discuss theoretical and practical implications, and limitations of our proposal.

Conventional software development processes, in general, assumes that users are already defined or can be easily identified. Users interact with the system, through a set of requirements that are elicited in the development process. In the case we describe, we have a description of the community goal and an idea of potential or existent users, but we need to establish how to motivate the users to engage, participate, and fulfil the community goal. We know that incentive mechanisms are used to encourage individuals' behaviour. In case of virtual communities, incentive mechanisms are designed to stimulate members' participation in online tasks.

In order to design incentive mechanisms for a given virtual community, we need to identify the online tasks that require participation improvement. The identification and understanding of the online tasks should be based on the analysis of the virtual community. As incentive mechanisms act on members' motivation, we need to reason

about motivating factors that drive members in participating of online tasks. Each task may be associated with distinct factors. For each member, a task has an intrinsic purpose that makes him/her work, although this may vary from person to person. Before accessing motivations, we then need to understand the members themselves by investigating attributes that are useful to characterize such members. In this way, we do not intend to make rigorous science. Rather, our aim is to provide some indicative findings as to how the various sociological, psychological and other findings might be integrated into a framework that might guide designers when they think about incentive mechanisms for online communities.

The proposed framework focuses on defining incentive mechanisms for addressing members' motivations, regardless of the kind of virtual community; however a virtual community can include other kinds of public, such as firms and institutions (governmental or not). We think that the framework can be improved to include motivations of both people and the formal goals of organizations. Another aspect to consider is that the proposed framework requires identifying the characteristics of community, tasks and members, and also motivating factors that are required for planning incentive mechanisms. We have, in the main, taken these dimensions from the existing literature. This does not mean that other and equally important elements are not out there waiting to be discovered. Only detailed empirical work on the evolution of online communities can provide such material.

Online communities are influenced by changes in distinct context in the external environment, such as political, religious, economics and social. For instance, Johri et al. [Johri et al., 2011] examine a MySQL newcomer forum before and after two takeover announcements by distinct companies. The acquisition by a friendly company was found to have no effect on participation, whereas, the acquisition by a company perceived as not very friendly had a negative effect on participation. Designers need to be aware to the effects on participation driven by the external factors, since it can influence their analysis in a way to select suitable incentives for a particular phase of the community. The external environment can be also useful to define offline incentives, such as to promote the virtual community in the media, so people get interested and visit the community. The proposed framework is restricted to the definition of online incentive mechanisms. We believe that the offline and online incentive mechanisms should work in a consistent manner, and some additional investigation is required.

The fact of having individuals organized in groups can generate apprehensions or inhibitions, called social fears. Performance can be enhanced or impaired in the presence of persons who can approve or disapprove our actions [Cottrell, 1972]. In case of negative emotions during collaboration, a member can feel unpleased about a task, ashamed or anger with others and affective detached from the group or community [Lawler, 2006]. Some factors related to social fears are: privacy concerns [Kurdziolek et al., 2010], fear of being identified, fear of misleading others, fear of disrupting own image, fear of being criticized, and fear of punishment [Mousavidin and Goel, 2009]. In our approach, we focus on the identification of motivations that lead to participation; however, designers must to consider the possible interference of social fears when defining incentives.

The conducted case study was intended to be evaluative, relying on mainly qualitative analysis to investigate the framework's benefits and outcomes, as

perceived by participants. The data from the study was based on a real-world need and reflected, at least to a degree, the complexity of the scenario. These evaluations were small-scale, reflecting recruitment difficulties and limits on available time. Results could be made more robust by comparison with other, more objective data concerning usage, and is something we intend to do in the future. Nevertheless, we are confident that our evaluation at least pointed to the need for some kind of framework to support the definition of online incentives.

This does not mean the framework solves all problems. Framework effectiveness can be influenced by aspects we could not control for, such as the commitment of designers to the project execution, designer's knowledge about the community, and the correct involvement of community members to understand their needs, expectations and problems. Other aspect is that the framework is dependent on the kind of data used as input, so designers should be aware that information they have may not be adequate or sufficient. For instance, a community may be composed of a diversity of individuals sometimes not well identified, especially in case of large and public communities, and whose motivations are also diverse. The definition of incentives is also related to creativity, which is a sound basis for proposing innovative incentive mechanisms. So, the application of the proposed framework alone does not guarantee the success of the mechanisms in improving participation, but acts to support it.

It may be difficult to enhance participation in some circumstances even with incentive mechanisms. There may be circumstances where incentive mechanisms are not an appropriate solution, or where designers are not able to propose effective mechanisms for a particular group to participate in a task. In this situation, incentives for other groups can be explored in order to guarantee effective division of labour [Fang and Neufeld, 2009]. Sometimes, barriers can prevail in particular settings and limit members' participation. Barriers can then mitigate against participation regardless of the incentives we propose. Some examples of barriers include personal preferences (e.g. someone is not stimulated to participate in communities about games or food recipes), the lack of abilities or skills (e.g. idiom), and the lack of resources (e.g. time, computer, Internet access) to perform a task [Bross et al., 2007], [Hsu and Lu, 2007], [Mantilla, 2009], [Picazo-Vela, 2011].

As a further limitation, we consider that our approach is focused on short-term initial participation, after the design of a new community or the redesign of an existing community, since most of the information is contextually considered, including time window. We consider that long-term ongoing participation will require a systematic analysis. For long-term ongoing participation, we argue that it is necessary to evaluate the mechanisms' performance continuously, aiming to keep the online tasks attractive to members. The evaluation requires monitoring the community system's usage during the mechanisms' operation. By monitoring mechanisms, it is possible to suggest some preventive and corrective actions to the mechanisms. The topic of monitoring incentives needs a dedicated research for a better investigation of how to verify incentives' effectiveness during community operation. In this case, two main points should be considered. The first point is the challenge to infer members' satisfaction in an indirect way without having to ask them through surveys. The second point is the intrinsic community dynamic, for instance it can be expected that participation decreases in some situations or periods of the year.

6 Conclusions and Future Work

Online incentive mechanisms should lead members to participate in a virtual community more fruitfully and in a sustained manner. The proposed framework aids designers of virtual communities to propose online incentives that might furnish that outcome. The framework includes structured activities to reason about the community context and the factors related to members' motivations. It also guides the analysis of the incentive mechanisms' suitability with respect to context adherence, implementation effort, maintenance effort, and possibility of secondary effects. The framework can be used in the development of a new community or to review the design of an existing community. One suggestion for designers is to apply the framework in a spiral evolution, by defining simple mechanisms and continuously improving them, thus maximizing flexible appropriation.

Previous research related to participation engagement considers specific kinds of virtual communities. Researchers focus on understanding members' characteristics that influence their participation, or even motivations that move members to participate. Task characteristics are also advocated as moderating factors of participation. Other studies rely on evaluating the effect on participation of a given incentive mechanism, and also which aspects (related to tasks, members' characteristics or motivation) can make the incentive more effective. However, there is no approach to guide designers when defining incentive mechanisms. Our approach fills this gap by providing a systematic guidance that identifies what is important to understand in order to propose incentive mechanisms to a given virtual community. We consider aspects as community context, critical tasks to have participation stimulated, members that can be involved in such tasks, as well as motivations that move members to participate. We also discuss aspects' characteristics that were pointed out as relevant in previous investigations, including, community characteristics as size and orientation, tasks' characteristics as objective and subject, members' characteristics as social ties and cognitive aspects, members' motivations as belonging, esteem and self-actualization. We go a step further by indicating concerns that can reduce the potential of an incentive mechanism, for instance when it requires a great maintenance effort to be used, or even when it opens space for misuses or infractions.

Our proposal and case study bring important implications to designers of virtual communities. First, designers now have a structured way to reason about incentive mechanisms to promote online participation. Creativity is essential when defining incentive mechanisms in order to identify attractive and innovative ideas. The proposed framework supports such creative process in a way to certify if defined incentives are well grounded, by respecting community context and members' desires. Both canvas and key questions promote valuable discussions by designers, aiming a better comprehension of a chosen scenario. The case study exemplifies a usage of the framework, which is interesting when designers start using the framework. The case study points out benefits of the framework to designers, mainly due to the indication of critical knowledge to be considered. If a structured process is not employed, such knowledge can be much harder to identify. The case study also supports that the proposed framework is adequately described, with a well-defined structure and with coherent and intuitive activities. Designers can reuse or adapt the

framework to define incentive mechanisms in distinct scenarios, for instance to consider other publics (such as firms and organizations) and not only individuals as part of the virtual community. Designers can even use the framework ideas to propose offline incentive mechanisms, which include initiatives not implemented in the online system itself, but in the environment where members interact. Other possibility is to apply the framework to small teams developing long or short-term activities online.

In near future, more experiments shall be conducted to a better evaluation of the framework performance, considering more participants, and communities with distinct orientations. An immediate related work is to investigate the effectiveness of incentive mechanisms already employed in virtual communities, which may require the identification of appropriate performance indicators. The proposed framework can be adapted to reason about the adequacy of an existent incentive mechanism in case of changes in the virtual community, such as the appearance of a new group of members, and the modification or creation of a task. Furthermore we do not know whether our framework would be suitable for designing social network sites, which allow individuals to articulate and make visible their social connections but are less explicitly task-based. Further research, hopefully, will make such matters clearer. We desire to investigate gamification techniques in order to complement our framework with specific considerations about incentive mechanisms. Other studies should consider stimulating members to participate in the definition and management of incentive mechanisms, since members themselves have better knowledge of their expectations and motivations. Further investigations need to be made in this trend.

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