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Gamification as a Disruptive Factor in Software Process Improvement Initiatives

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Abstract: For any Software Process Improvement (SPI) initiative to succeed human factors, in particular, motivation and commitment of the people involved should be kept in mind. In fact, Organizational Change Management (OCM) has been identified as an essential knowledge area for any SPI initiative. However, enough attention is still not given to the human factors and therefore, the high degree of failures in the SPI initiatives is directly linked to a lack of commitment and motivation. Gamification discipline allows us to define mechanisms that drive people's motivation and commitment towards the development of tasks in order to encourage and accelerate the acceptance of an SPI initiative. In this paper, a gamification framework oriented to both organization needs and software practitioners groups involved in an SPI initiative is defined. This framework tries to take advantage of the transverse nature of gamification in order to apply its Critical Success Factors (CSF) to the organizational change management of an SPI. Gamification framework guidelines have been validated by some qualitative methods. Results show some limitations that threaten the reliability of this validation. These require further empirical validation of a software organization.

Keywords: Gamification, Software Process Improvement, Organizational Change Management
Categories: D.2.7, D.2.9

1 Introduction

The software industry is one of the most important industries in the world [Colomo-Palacios, Fernandes, et al. 12]. Thus, in order to meet the increasing software needs, companies around the globe have made a tremendous effort in SPI [García et al. 12]. Within the extensive literature devoted to studying SPI challenges some aspects should be highlighted, especially change management as one of the main issues to

tackle in SPI initiatives [Beecham et al. 03, Mathiassen et al. 05, Stelzer and Mellis 98].

Traditional change management studies suggest that in order to get results from initiatives, four related organizational elements must change: process, structure, management and people [Applegate 94]. Regarding the latter, people can be seen as the main factor in SPI that needs to be encouraged and supported in an organization [O'Connor and Basri 12]. Indeed, it can be stated that the software industry is highly dependent on people [Colomo-Palacios et al. 13, Colomo-Palacios, Fernandes, et al. 12]. Therefore, in change environments all the people in the organization are required to change their attitude, and acquire and practice new behaviours and skills aimed at improvement and better performance [Moitra 98]. Attitude towards change is one of the crucial human aspects addressed in modern SPI approaches [Korsaa et al. 12].

Furthermore, several human aspects such as the motivation and commitment have been pointed out as CSF for software projects [Hall et al. 09], whereas in the SPI area, improvement initiatives cannot generate the expected benefits if the human aspects do not receive sufficient attention [Baddoo and Hall 02, 03]. However, enough attention to these human factors is still not given [Baddoo and Hall 02, 03], and, as a consequence, over 70% of the SPI initiatives fail [Ferreira and Wazlawick 11]. Besides, SPI has a low level of adoption and limited success [Niazi 06]. In this context, it is necessary to use mechanisms that allow working on the main human factors that are essential for the success of the SPI initiatives, as for example the required commitment during the change process and the motivation of the personnel involved in the SPI [Lepasaar et al. 01, Stelzer and Mellis 98].

By using psychological theories and several game elements, gamification has been identified as a tool that leads motivation and commitment in a number of functional areas [Deterding 12], especially in the domain of software engineering [Dorling and McCaffery 12]. Consequently, gamification can be seen as a facilitator for change acceptance due to its capacity to foster the desired behaviour on agents [Deterding 12]. In this way, gamification is considered a disruptive factor among the SPI, which will enable to deal with one of the most important problems under organizational change management in SPI initiatives: the lack of focus on people aspects.

This research paper takes advantage of the transverse nature of gamification, applying its foundations, in a systematic way, to the organizational change management of SPI. Linking both knowledge areas, OCM and gamification, will increase the motivation and commitment of the software professional groups and provide a methodological approach for managing the organization's change. In the same way, some qualitative methods, as for example the Focus Group and Delphi Method are used to validate a number of Critical Success Factors (CSF). These practices represent the main guidelines in the gamification framework. Results show that although the most representative guidelines have been validated, there are also some limitations threating the reliability of the validation. So, for future research it is encouraged to go beyond such limitations and, furthermore, to establish an empirical validation of a real organization when implementing a new SPI initiative.

2 Background

Gamification is the use of game elements in non-game contexts [Deterding, Khaled, et al. 11] to modify and influence the behaviour of people [Werbach and Hunter 12]. It only amplifies the desire to compromise based on behavioural or psychological propensities that have existed in human beings from conception [Mittelmark and Riccio 12].

A gamification proposal can increase the motivation and commitment that will entail a rise in productivity and performance of the staff involved. In addition, gamification encourages competitiveness [Mittelmark and Riccio 12], and therefore, innovations within the organization. This increase in the competitiveness and visibility of the results will foster the implementation of a community based on merit and its performance excellence. Also, gamification can:

a) encourage collaboration and participation,
b) allow to promote the rationalization of internal and external processes, being able to identify and eliminate weaknesses [Mittelmark and Riccio 12], amplifying the user's feeling of progress [Dorling and McCaffery 12], and
c) enhance the engagement in the daily business processes [Hägglund 12].

However, any process that integrates gamification will be exposed to a number of questions and drawbacks. Thus, it should be noted that a proposal for gamification is not easy to manage, determine or measure the objectives and it implies a certain philosophy of trial and error [Mittelmark and Riccio 12]. In addition, there is a risk of misunderstanding the conceptualization and incorrect implementation of game elements [Mittelmark and Riccio 12]. Finally, gamification could go against the ideals of the organization by introducing excessive competitiveness that is highly demotivating for all involved in the process [Cherry 12, Werbach and Hunter 12].

Although in its early years gamification was only used for marketing [Burke 12], the universal and transversal nature of gamification now permits to apply its several foundations to multiple functional areas [Deterding 12]. Therefore, some "gamificated" applications focus both on employees [Mittelmark and Riccio 12] and external customers [Burke 12, Huotari and Hamari 12, Mittelmark and Riccio 12]. Today, some applications in the field of improvement, innovation and streamlining processes are being developed [Dorling and McCaffery 12 Herranz et al. 13], and some regarding product innovation and crowdsourcing [Burke 12].

All available data on consultancy reports point to an unstoppable growth of gamification, and its widespread adoption seems to be close too. However, despite high expectations, some incorrect implementations are expected, and consequently firms would not be able to meet its objectives [Burke 12, Mittelmark and Riccio 12].

2.1 Foundations

Gamification can be found certain psychological theories and in the application of game elements. Gamification is based on three psychological theories: the Fogg Behavior Model[1], the self-determination theory[2] and the flow theory

[1] http://www.behaviormodel.org
[2] http://www.selfdeterminationtheory.org

[Csikszentmihalyi 97]. The Fogg Behavior Model indicates which factors are necessary for a behavior to take place. It is often used in game environments and in behaviour modification schemes (outlines) through gamification [Frang and Mellstrand 12, Hägglund 12]. Moreover, the self-determination theory identifies a number of basic needs that must appear in any gamification proposal. Finally, the flow theory sets an optimal mental status to perform a specific task. In order to achieve this status a match between the difficulty of the task and the skills of the person is required [Csikszentmihalyi 97].

Game elements are another cornerstone of gamification. Due to the lack of maturity of the discipline, many authors use the terms dynamic and game mechanics interchangeably [Herranz and Colomo-Palacios 12]. However, one of the most coherent and holistic meanings is the one used by [Werbach and Hunter 12]. These authors point out that there are three fundamental elements of the game: dynamics, mechanics and components of the game. The first of these elements, the dynamics of the game has to do with to empower the objectives and the potential effects on the people involved. In fact, these dynamics are highly related to the human needs and concerns that motivate people intrinsically [Werbach and Hunter 12]. Thus, despite the absence of a closed taxonomy, we might find those dynamics that enhance emotions, narrative, sense of achievement, or even relationships [Werbach and Hunter 12]. Game mechanics can be considered as the basic actions that motivate and engage the user, and thus achieve the objectives specified by the game [Werbach and Hunter 12]. Such mechanics aim to govern the behaviour of people through incentive systems, feedback and competition, among others, with a reasonably predictable outcome [Dorling and McCaffery 12]. And finally, game elements refer to specific instances of the dynamics and game mechanics [Werbach and Hunter 12]. Although the number of game elements is infinite and its limit is imposed only by creativity [Dorling and McCaffery 12], the most common ones are points, badges and leaderboards [Werbach and Hunter 12].

2.2 Gamification in Software Engineering

Through the basics of gamification, and taking advantage of its transversal nature, it is possible to transfer the motivation and commitment to a business as a key factor for success and ultimately for the acceleration of Software Engineering improvements [Dorling and McCaffery 12].

In fact, although there are few empirical validations [Mekler et al. 13], some lines of research are emerging in areas such as SPI [Dorling and McCaffery 12, Herranz et al. 13], design and development of software [Bacon et al. 09, Dubois 12, Passos et al. 11, Singer 12, Snipes et al. 13] and methodologies [Dubois and Tamburrelli 13].

Altogether, a proper application of competition mechanics and cooperation will foster the cooperation of the people involved at the same time as competitiveness is encouraged within the different teams. To achieve commitment through a continuous feedback it will be necessary to establish a reward and incentives system to encourage intrinsic motivation of the staff. In addition, the rationalization of the improvement and development process will be possible by promoting a sense of progress and giving coherence to professional performance. Thus, gamification is configured as a single stage to improve the motivation and productivity of everyone involved.

3 Towards a gamification framework for SPI initiatives: A focus on organizational change management

Change is inherent to SPI. The failure in SPI implementation can be explained by the lack of maturity of the organizations in the implementation and institutionalization of SPI initiatives for those people that will be affected by the new methods of work [Moitra 98]. That is to say, any proposal for improvement can generate the promised benefits without a change of attitude and behaviour of the agents [Moitra 98]. However, the agents' motivations vary among the different groups involved, and it is necessary to customize the strategy in order to enhance the effectiveness of the SPI initiative [Baddoo and Hall 02]. Despite its importance, there are few models that support work in the management of organizational change, and although there are certain motivational proposals in this respect, there is a need for a framework that has an impact on the main human factors of each of the professional groups involved in the SPI.

In this context, gamification is configured as a suitable candidate to increase the motivation and commitment in the management of organizational change of SPI and, thus, facilitate the adoption of SPI improvements and increase its success. The goal of this research is to establish a framework that enables the integration of specific gamification mechanisms in the organizational change management of SPI.

To establish the gamification framework, it is necessary to emphasize the main motivational factors of each of the professional groups of SPI, and to define a gamification proposal, from lowest to highest level of detail. This proposal corresponds to the core of the gamification framework.

3.1 Gamification proposal

Commitment is found at all levels of a software organization [Abrahamsson 01] and it has been identified as one of the main factors of success for any SPI initiative [Niazi 09, Stelzer and Mellis 98]. In fact, the lack of commitment would result in demotivated personal [Abrahamsson 01].

The gamification proposal aims to increase the motivation and commitment of the people involved in the SPI initiative and, therefore such a task would begin from the motivational factors studied by [Baddoo and Hall 02, 03]. In this case, customization of the strategy is indispensable.

First of all, a high-level gamification proposal is introduced and adapted to the most general aspects of the people involved, the organization as a whole, its culture, and the main tasks of the SPI initiative. The aim of this proposal is to trace, in general terms, the gamification application that will subsequently be adapted to each of the groups of software professionals. Once this high-level proposal is completed, the next step would be to design a detailed one at a lower level, focusing on the principal motivational factors (motivators and demotivators) of each of the software professionals groups studied by [Baddoo and Hall 02, 03].

This research proposal on gamification will be the core of the methodological gamification framework of SPI already introduced. The goal of such a proposal is to plot a route when implementing gamification in the SPI initiative. However, these guidelines are only an approximation and are totally flexible since they depend,

among other factors, on the professional groups involved, the characteristics of the organization, the specific activities of the SPI initiative, as well as the creativity and criterion of the professionals in charge of implementing the gamification framework. It would also be important to adapt this proposal to the different social, cultural, and even gender diversities. Furthermore, participation of the people involved in the process should be completely voluntary [Werbach and Hunter 12].

HIGH-LEVEL PROPOSAL

In order to transfer the benefits from gamification to the SPI environment a set of game mechanics and elements can be used which, based on the guidelines proposed by [Werbach and Hunter 12], must be selected according to the dynamics of the game. In this way, gamification can improve relationships and communication between the existing roles and the SPI infrastructure, and it can also enhance the feeling of progression of SPI initiatives [Herranz et al. 13]. In addition, it can reinforce the narrative of the actions within the SPI, even with techniques such us storytelling [Hsu et al. 13], providing a feeling of. On the other hand, gamification promotes certain type of behaviors, such as competitiveness or altruism [Werbach and Hunter 12].

Regarding game mechanics, few challenges can be used to set specific objectives for the SPI initiative activities. All these tasks will require an effort aligned with the skills of the professionals involved [Werbach and Hunter 12]. Such mechanisms could include those competition techniques, which provide a setting in which winners and losers get along. To prevent excessive competitiveness, it is advisable to implement some cooperation mechanisms in which the individuals of each group of professionals collaborate in order to achieve a common goal [Cherry 12, Werbach and Hunter 12]. Commitment is supported through inter-organizational cooperation, where participants are involved in a friendly competition in relation to the progress of the SPI initiative [Mathiasen et al. 05].

It is essential to establish a mechanical feedback that provides performance information to the staff for this project to succeed. [Werbach and Hunter 12]. If the feedback is based on real time benefits it will become greater [Werbach and Hunter 12]. Also, the establishment of an incentives mechanism that rewards certain specific achievements, whether individual or collective, is indispensible. These rewards should be upward, based on effort and risk, [Dorling and McCaffery 12] in order to enhance long-term commitment. Bonuses, promotional opportunities and other incentive schemes are also useful tactics to expand commitment on any project of SPI [Mathiasen et al. 05].

Game components represent specific ways to carry out the game dynamics and mechanics previously established [Werbach and Hunter 12]. Hence, bagdes can be used for recognition while accomplishments can be used to represent the objectives achieved [Werbach and Hunter 12]. These badges (achievements) will be assigned to individuals or groups of software professionals involved in this SPI initiative [Herranz et al. 13]. In addition, leaderboards could be used. They give visibility to the progression and badges of the most successful individuals within the organization [Hägglund 12], while using levels to define every stage in the improvement progression or performance of the SPI activities [Herranz et al. 13].

LOW-LEVEL PROPOSAL

One of the main reasons for failure when using gamification is to treat everybody the same way, instead of customizing a gamification proposal for each group of people, location, and organization [Deterding, Dixon, et al. 11]. For this reason, after developing the high level proposal, it is necessary to personalize it even more with some specific techniques for each of the SPI professional groups. This will result in a detailed proposal that each group of professionals (senior management, project managers and developers) will enhance specific motivating factors studied by [Baddoo and Hall 02].

In the short term, and with the intention of bringing forward the SPI initiative, it is recommended to focus on common motivators among the different software professional groups [Baddoo and Hall 02]. Within the common motivators that can be boosted by the use of gamification, we can find, the need for clear and visible success of the SPI initiative and the existence of a motivation incentive schemes [Baddoo and Hall 02]. Regarding the SPI success, gamification may contribute to greater awareness of the objectives through several game elements such as leaderboards or progress bars. Moreover, these components often help to foster the sense of progress in the activities undertaken. At the same time, gamification will contribute to increasing commitment throughout the organization and, in particular, senior managers, that group being one of the main factors for success in the SPI initiatives [Lepasaar et al. 01, McFeeley 96, Stelzer and Mellis 98]. Furthermore, the rewards and incentives approaches are highly motivating for all groups of professionals [Baddoo and Hall 02]. For this reason, the establishment of a set of customized incentives should be one of the cornerstones for any proposal in relation with gamification within SPI.

Beyond the common motivating factors, each group of software professionals has some specific factors, some of which may be enhanced with gamification techniques such as points for presenting proposals, voting systems controlling the quality of these proposals and incentives to reward participation. Furthermore, participation could be organized in teams to dramatically increase the success of the system [Epstein 13]. In fact, successful SPI depends on people with sufficient information and training who are actively involved [Pries-Heje et al. 10].

Feedback is an essential element for every SPI gamification proposal [Herranz et al. 13] and it is one of the most motivating factors, both for developers and senior management [Baddoo and Hall 02]. This feedback should be real-time based when possible [Werbach and Hunter 12]. Positive aspects will be emphasized to encourage and negative ones for individuals change their behaviour [Perryer et al. 13]. Through the game elements (points, progress bars, and leader boards) developers can check on the progress of their tasks while top management will have full knowledge of the overall progress of the project.

As mentioned earlier, senior management commitment is one of the main success factors of SPI. Precisely this commitment, and its perception by developers and project managers, is one of the main motivating factors in the SPI initiatives [Baddoo and Hall 02]. Dashboards can be implemented to increase senior management commitment. These dashboards should make use of gamification techniques to control the evolution of the SPI and its contribution to the business objectives [Herranz et al. 13]. Once this commitment has been made, senior management must

ensure commitment at all in keeping with clients' demand and relying on the incentives systems [Mathiasen et al. 05]. Gamification might be one of the key tools to achieving such a commitment [Herranz et al. 13]. Regarding the rest of software professionals, commitment can be obtained through staff participation, mainly those most affected by change [Hardgrave and Armstrong 05]. These people will be more enthusiastic and committed to the change process and the probability of success will increase.

Additionally, it is possible to extend the scope of the low level proposal by emphasizing the non-motivator factors of each group of software professionals [Baddoo and Hall 03].

3.2 Gamification framework

3.2.1 Overview

There are many guidelines and factors to keep in mind when using gamification. Many of these have been identified by well-known international consultants such as PricewaterhouseCoopers [Mittelmark and Riccio 12] and Deloitte [Palmer et al. 12]. Other authors [Burke 12, Werbach and Hunter 12] have gone further and have defined high level processes for the implementation of gamification in all types of organizations. In this context, it is necessary to define a methodological framework for the application of gamification, which takes into account the peculiarities of software organizations and conforms to the SPI. With the aim of promoting the adoption of SPI initiatives, a methodological framework focused on organizational change management of SPI is suggested and it will later be adapted to the specificities of each software professional group. This framework is based on incremental iterations that allow the groups involved to deal with resistance to change. Processes can be improved and adapted in an SPI environment [Borjesson and Mathiasen 04].

3.2.2 Gamification framework phases

As represented in Fig. 1, the gamification framework presents seven phases. The first phase of the framework considers the feasibility of implementing gamification in a software organization. In the second phase some business objectives are established to determine whether gamification is feasible. The third phase explores all the professionals groups' motivations and profiles. Later, in the fourth phase, the activities to gamify are identified and discussed, and some of the essential aspects of the SPI proposal are considered.

The fifth phase is the core of the gamification framework. In this phase, the gamification proposal is developed. This proposal focuses on groups of software professionals. In addition, metrics and assessment techniques and feedback processes are established. In the next phase the implementation of the gamification proposal is issued. The gamification framework ends with the analysis of outcomes and objectives achieved.

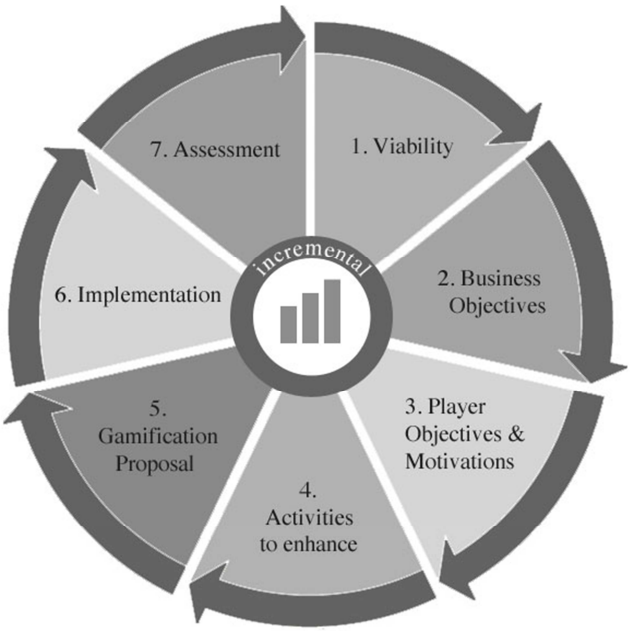

Figure 1: Phases of the gamification framework

PHASE 1: FEASIBILITY

Not all situations are suitable for the application of gamification [Mittelmark and Riccio 12, Werbach and Hunter 12] and it is important to foresee this in order to avoid potential conflicts [Burke 12]. Therefore, it is necessary to have the support of senior management to analyse briefly the SPI activities and the organizational environment [Herranz et al. 13]. Before applying the framework, a proper estimation must be carried out to check if gamification will contribute to the business objectives [Werbach and Hunter 12]. Also, to verify whether an increase in motivation and commitment would be feasible while diminishing resistance to change.

PHASE 2: BUSINESS GOALS

Business objectives expected from the implementation of this framework must be defined in a simple and realistic manner [Herranz et al. 13]. In addition, to achieve a sustainable proposal on gamification, these business goals should be aligned with those of the groups involved [Werbach and Hunter 12]. The SPI infrastructure in the organization will be taken into account.

PHASE 3: USER'S OBJECTIVES AND MOTIVATIONS

Not everyone reacts in the same way to the same stimuli [Werbach and Hunter 12] and this can be seen in any SPI initiative [Johansen and Pries-Heje 07]. Therefore, it is necessary to analyse the motivational factors, both intrinsic and extrinsic, of the professionals groups involved to perform a precise description of the participants (players) in the gamification proposal.

For this analysis, the study of the motivational factors will be needed [Baddoo and Hall 02, 03] for each of the software professionals groups (senior management, project managers and developers). It will be advisable to identify each group of professionals or SPI roles with a type of player in the players' classification for the gamification proposal [Bartle 96]. Although this classification is not intended to be a generalization of all kinds of games, it is considered as a good heuristics regarding how people participate in a gamification system [Hägglund 12].

PHASE 4: ACTIVITIES TO ENHANCE

In this phase some activities will be identified and analysed. These activities will be the ones that are intended to be promoted within the SPI proposal. During this phase, potential resistance to change should be estimated and the SPI metrics that determine success or failure of such activities will be defined as well.

PHASE 5: GAMIFICATION PROPOSAL

The gamification proposal is the core of the gamification framework and it generates the value proposition of gamification. To do so, it is necessary to define:

1. Dynamic, mechanic and game elements for the SPI initiative. This point refers to those described in Section 3.1. First, the high-level proposal is defined, and later it is customized (low level, in-depth) for each group of software professionals.
2. Metrics for each of the game elements defined above. It will be necessary to monitor the results of the gamification proposal in order to motivate and engage all professional groups, including senior management [Herranz et al. 13].
3. Feedback process through which the user receives information on his activity in real time. This will strengthen his motivation and will encourage him to continue with the proposal [Herranz et al. 13].

When defining the gamification proposal, some aspects reflected in models associated with the resistance to change [Kotter 09] and with the management of commitment must be considered [Conner and Patterson 82]. In addition, it would be advisable to keep in mind some key elements that optimize the accomplishment of tasks in gamification when applying change behaviour [Frang and Mellstrand 12].

PHASE 6: IMPLEMENTATION

In this phase, the gamification proposal from the previous phase at the technological level is executed and implemented [Herranz et al. 13]. However, before implementing the proposal it is necessary to communicate this to everyone in the organization. The current situation as well as the improvement needs and objectives to achieve must be provided in a transparent manner. Finally, to avoid the controversy of using game elements in the work environment the term "gamification" should not be used [Epstein 13].

PHASE 7: ASSESSMENTS
In the last phase of the gamification framework the results and the objectives achieved in such iteration will be analysed [Herranz et al. 13], and lessons learned during the implementation of the process will be collected to manage SPI proposals in the following iterations [Layman 05].

3.3 Critical Success Factors

In order to validate the general lines of the implementation of the gamification framework at the theoretical level, it is necessary to identify a series of potential CSF, which will be validated by experts in next section. Based on a certain level of abstraction, CSFs represent the guidelines for the correct application of the gamification framework and, therefore, compliance will determine the success or failure of the proposal.

For the identification of the CSF, a systematic review was dismissed due to the lack of literature and research on the subject. For this reason, it was decided that the researchers should perform and in-depth review of the framework proposed. Additionally, those factors that may be considered as guidelines regarding the implementation of the gamification framework were identified. Since the experts who were consulted for the validation are unaware of the details of the investigation, these factors reflect general aspects of the gamification related to the framework and, under no circumstances fall within the specific game elements or specific aspects of SPI.

Potential CSF identified in Table 1 represent the starting point of the validation later explained.

4 Validation

4.1 Objectives and plan

The ultimate aim of validation is to determine the theoretical validity, with a high level of abstraction, of the proposed gamification framework. In this sense, and given that the CSF represent the guidelines for the correct gamification framework implementation, validation will focus on knowing the validity and importance of the CSF previously identified.

Two methods of qualitative validation were used to achieve validation goals: focus group and the Delphi method. These research methods are very useful when the purpose is to analyse an area of interest, have an overview of a complex area or find differences rather than similarities [Colomo-Palacios, Soto-Acosta, et al. 12]. The Delphi method is generally considered as an appropriate method for studies that lack historical data and require the collection of experts' opinions.

CSF	Name	Description
1	Customized proposal	Gamification proposal must be customized to every organization, group of people or involved roles
2	Senior management commitment	Motivation and commitment at the senior management level must be prioritized to ensure the survival of the entire gamification system
3	Priority on common motivators	First, it is necessary to focus on the common motivational factors and then on the specific ones in order to obtain short-term results and ensure the support of senior management
4	People involved	It is essential that the people involved in the proposal participate in its design
5	Monitoring and feedback	Gamification initiative results should be monitored to assess the initiative engagement and provide feedback to participants
6	Previous communication	Communication, stating the need, current status and objectives of a gamification initiative prior to its implementation, is necessary throughout the organization
7	Gamification term	The term "gamification" should not be included when communicating the proposal
8	Framework consensus	Stakeholders' representative should always agree with the gamification proposal
9	Real time feedback	To ensure the participation of users, it is essential that they receive feedback in real time
10	Voluntary participation	People involved in the process should do so on a voluntary b
11	Pilot implementation	All proposals must first be applied on a pilot project
12	Cyclical and incremental implementation	Every gamification proposal should be applied in a cyclic and incremental manner
13	Viability study	It is necessary to estimate the gamification application feasibility in an organization
14	Business-users objectives	Business goals must be aligned with the users objectives

Table 1: Gamification Framework's Potential CSF

Validation planning consists of two main stages, each of them divided into three consecutive phases: planning, data collection and analysis. The first stage is to validate the CSF through a focus group with a panel of experts. The result of this stage is a list of the valid CSF. In the next stage, on the basis of these validated CSF, the Delphi method is used, with another group of experts, to know the relative importance of these CSF and be able to determine priorities and focus efforts. This planning is reflected in Fig. 2.

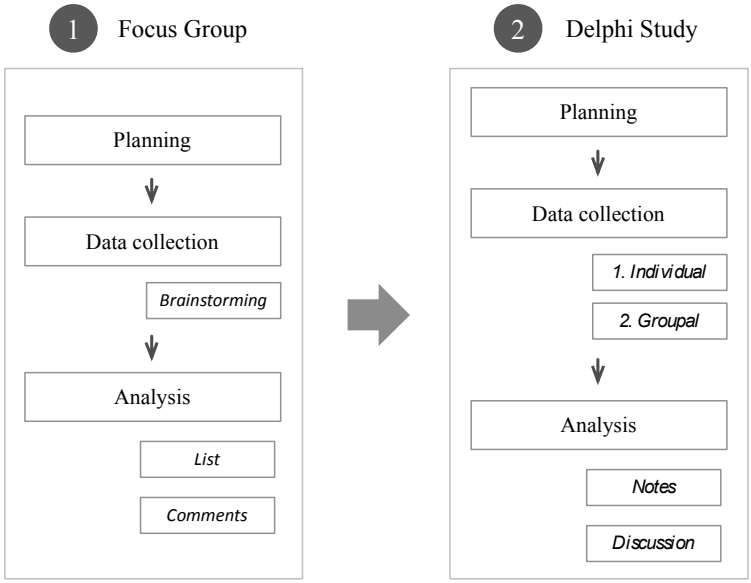

Figure 2: Stages and phases of validation

4.2 Focus group

PLANNING

Four gamification experts, all men with an average age of 37.5 years, were invited to the Focus Group by email. All four accepted to participate in the CSF validation session.

DATA COLLECTION

The session was taken on-site and lasted about 90 minutes. Data was collected during Spring-Summer 2013. Researchers took notes during the session.

Every CSF identified in Section 3.3 was dealt with independently. There was a brief brainstorming session where experts discussed and reached an agreement on the validity of each CSF. Then, a validated CSF List and rejected CSF List were generated. Finally both Lists were reviewed by the experts and showed they their conformity with it.

RESULTS AND ANALYSIS

The two CSF Lists generated from the Focus Group were:

- Validated CSF List: 1, 3, 5, 6, 8, 13 and 14. They are shaded in Table 1.
- Rejected CSF List: 2, 4, 7, 9, 10, 11 and 12.

50% of the CSF from Table 1 were rejected by the panel of experts and they explained why they were denied. Even though the experts agreed with what was the CSF represented, they were rejected because of their critical and universal nature. The experts indicated that it might be valid depending on the circumstances. All the

opinions of the experts were recorded by the researchers and will be taken into account under the validation discussion.

The validated CSFs (50% remaining) are the input of the next stage of validation, the Delphi method.

4.3 Delphi

PLANNING

The Delphi method aims to know the relative importance of the validated CSF in the previous stage. To participate in this study, ten experts in gamification were invited by e-mail to participate but only six of them agreed to participate. The participating experts were all men with an average age of 39.3 years. It is important to point out that none of the individuals who participated in the focus group were involved in the Delphi method. The application of the Delphi method consists of two rounds; a first round where experts classified the CSF in order of importance, and a second round where they agreed on a definitive ranking.

DATA COLLECTION

In this phase two rounds were conducted. In the first round, the validated CSF List was sent by email to the six experts. Their task was to sort the List by level of priority, from highest to the lowest. In the second round, the answers of all experts were incorporated into the same document. Then a conference call on Skype was made with the six experts at the same time. In this group conference the experts had to reach a consensus on a new CSF priority classification. They had to transform the document with the answers of all experts, maintaining the anonymity of each expert into a new classification. This conference was attended by a researcher and lasted approximately 20 minutes. Data was collected during Spring-Summer 2013.

RESULTS AND ANALYSIS

The results of the first round with the six experts are presented in [Table 2]. The numbers in the cells refer to the validated CSF generated by the Focus Group.

Position	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6
1st	1	1	3	14	1	1
2nd	13	14	13	1	3	13
3rd	14	3	1	3	13	3
4th	3	6	14	13	14	8
5th	5	8	6	6	5	14
6th	6	13	5	8	6	6
7th	8	5	6	5	8	5

Table 2: Round 1, classification of validated CSF for each expert

The results are shown in a stacked bar chart [Fig. 3] to facilitate the analysis of the results. Horizontal bars represent the classification given by the panel of experts for each of the validated CSF.

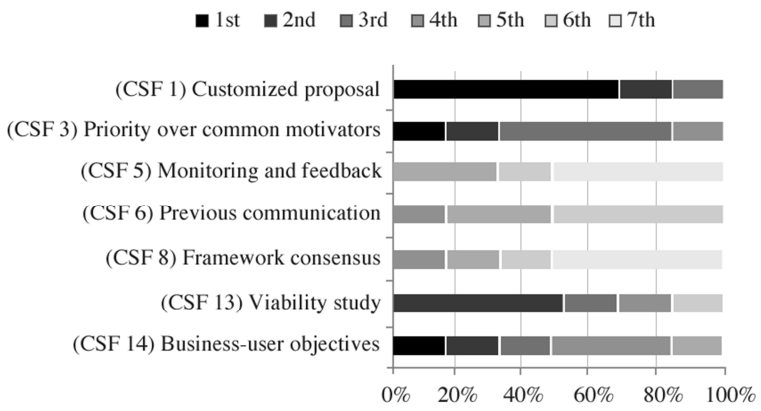

Figure 3: Round 1, individual classifications of validated CSF

At first glance, a low degree of consensus can be seen. The degree of consensus among experts can be measured through the Kendall's concordance coefficient (W). This coefficient measures the degree of correlation between classifications and it has a value between 0 and 1. Literature proposed that a high degree of consensus is reached when W >= 0.7; a moderate consensus degree when W = 0.5; and a weak consensus degree when W < 0.3. In this first round, the Kendall's concordance coefficient (W) is 0.2083, which indicates a weak concordance between the results of the experts consulted.

In the second round, the experts' panel prepared a new classification shown in [Table 3]. This table displays the final classification of the validated CSF.

Position	CSF
1st	(CSF 1) Customized proposal
2nd	(CSF 3) Priority on common motivators
3rd	(CSF 13) Viability study
4th	(CSF 14) Business-users objectives
5th	(CSF 8) Framework consensus
6th	(CSF 6) Previous communication
7th	(CSF 5) Monitoring and feedback

Table 3: Round 2, final classification of validated CSF

This second round shows some interesting results. Despite the weak correlation between experts in round-1, the final classification in this round shares many positions with those provided by Expert-5 in the round-1 classification [Table 2] This fact, beyond a mere coincidence, is due to the fact that this expert was the most active and argued most convincingly during his classification. As a result, the rest of the experts' panel ended up agreeing on much of his arguments.

Despite the influence of expert 5, we can observe that CSF 1, "Customized proposal" was the most important factor in the first round for almost all experts. On

the other hand, CSF 3, "Priority on common motivators" is placed in second position when in the first round. For 4 out of 6 experts, it was not even in one of the top two positions. In addition, CSF 13, "Viability study" occupies the third position although in the first round it appeared in only half of the experts' classifications.

With regard to the fourth factor, CSF 14, "Business-users objectives", a slight divergence with respect to the first round can be observed since two of the experts classified it in first and second positions. This kind of divergence gets clearer with the fifth factor CSF 8, "Framework consensus" since two experts in the first round rated it as the least relevant factor of all CSF. Finally, it should be mentioned that this kind of divergence does not occur between the sixth and the seventh classified factors CSF 6 and 5, "Previous communication" and "Monitoring and feedback" respectively, since they simply alternate their positions with respect to the first round.

5 Discussion

With the validation results, some aspects can be highlighted. With regard to the CSF that was validated, CSF 1 "Customized proposal" corresponds to one of the main differentiating factors of the gamification framework and the expert panel validated it immediately. This need for customization is considered essential (indispensable), not only for authors within the gamification area (e.g. [Hägglund 12]; [Werbach and Hunter 12]; [Zichermann and Cunningham 11]), but also for those in SPI research (e.g. [Baddoo and Hall 02, 03]; [Johansen and Pries-Heje 07]). CSF 3 "Priority on common motivators" was validated and considered of high interest. This CSF, which is based on the investigations of [Baddoo and Hall 02, 03], emphasizes the need for customization and represents one of the special features of the Low-Level gamification proposal.

Furthermore, CSF 5 "Monitoring and feedback" corresponds to a fundamental aspect of gamification proposal and aims to motivate and encourage participation. The experts' panel validated this CSF and its importance has been portrayed by multiple authors (e.g. [Dorling and McCaffery 12]; [Perryer et al. 13]; [Werbach and Hunter 12]). On the other hand, CSF 6 ("Previous communication") was also validated. This factor points out the benefits of notifying individuals prior to the implementation of the gamification framework, so it cannot be considered a minor aspect. In fact, there are other motivational proposals [Ferreira and Wazlawick 10] oriented to enhancing the phases of the IDEAL model [McFeeley 96], where the main tool is communication through meetings, workshops and discussion forums. To conclude with the validated CSF, the expert panel validated the CSF 8 "Framework consensus" and CSF 13 "Viability study", but for both of them the experts indicated the need to develop such tasks in a flexible way. The last of the CSF, CSF 14 "Business-users objectives" was also validated and corresponds to one of the main guidelines of authors such as [Burke 12, Werbach and Hunter 12] in order to make the gamification proposal sustainable and to avoid the disadvantages mentioned in Section 2. This factor is also present in general software management framework e.g. []

In relation to the CSF that was previously rejected, it should be noted that most of the factors were considered interesting, but their universal character was rejected. For example, the experts rejected CSF 7, "Gamification term", arguing that the use or not

of such a term would depend on the nature of the each organization. However, it was found that gamification may be seen as a fashion. Therefore, this must be taken into account in order to take advantage of it. CSF 11 and 12, "pilot implementation" and "cyclical and incremental implementation", respectively) were also considered interesting, and the reason for the rejection was the same in both cases: they were not regarded as critical for small projects. Despite these statements by experts, it is considered that the validity of the gamification framework is not affected since, as mentioned before, SPI initiatives tend to be complex and large-scale projects [Ngwenyama and Norbjerg 10]. On the other hand, CSF 9 "Real time feedback" was rejected and it was argued that such feedback would only be in real time if game mechanics require it. This argument is contrary to other authors as [Werbach and Hunter 12].

Not every factor suggested as CSF was chosen for the panel of experts. Thus, CSF 4 "People involved" was rejected unanimously. Apparently, it is not suitable for an individual to become involved in the design of a system where they will later participate as a player. Therefore, this rejection implies that the gamification expert will be the main person responsible for the design of the gamification proposal.

Two of the most remarkable cases of rejection were CSF 10 "Voluntary participation" and CSF 2 "Senior management commitment". Regarding the first, experts considered that sometimes people do not want to participate voluntarily in such a system, but in the end they were delighted with the experience. Authors such as [Werbach and Hunter 12] disagree with this argument and with the theory of self-determination referred to in Section 2. To conclude the discussion on the rejected CSF, the paradox of the CSF 2 "Senior management commitment" rejection should be noted. Experts argued that the commitment priority was on the rest of the organization and from them to level up to the senior management. Although the gamification framework considers the commitment at all levels, it is likely that experts are unfamiliar with those scientific studies about SPI that encourage to prioritize senior management commitment (e.g., [Baddoo and Hall 02]; [Mathiasen et al. 05]; [McFeeley. 96]; [O'Hara 00]; [Stelzer and Mellis 98]).

As has been proved, despite the rejected CSF, the theoretical validity of the gamification framework has hardly been influenced. However, the low degree of consensus (W=0.2083) among the experts at the second stage (Delphi method) and some arguments against the scientific studies, question the characteristics of the selected experts' sample. Perhaps one of the reasons for this low degree of consensus lies in the incipient state of the gamification as a knowledge area and the lack of scientific literature on the subject. For these reasons, the CSF final classification done by experts continues to be of interest, but multiple constraints that threaten the reliability of validation have been detected. These limitations are presented in the following section.

6 Limitations

Although this is an introductory investigation, it highlights the major constraints when achieving a reliable and relevant validation. These limitations are linked to the sample size and quality. With respect to the size, in the second stage of validation (Delphi method), the sample only consisted of six experts, while the literature recommends a

size of Delphi panel from 10 to 18 experts [Okoli and Pawlowski 04]. Regarding quality, it was very difficult to find experts with a great deal of experience and expertise in gamification.

The reason for these limitations lies in the novelty of the study object. Gamification has a brief historical and empirical validation [Mekler et al. 13]. This fact has a direct impact on the quantity and quality of the scientific literature found and it provides skewed knowledge to the community. As a result, results cannot be generalized, and all the limitations described threaten the reliability of the validation.

7 Concluding remarks

Any SPI initiative that aims to succeed must actively involve all, influence their daily activities [Pries-Heje et al. 10], and their motivation [Lepasaar et al. 01, Stelzer and Mellis 98]. Their commitment is considered a critical factor in the adoption of these improvements [Niazi 09, Stelzer and Mellis 98]. The basis on which gamification stands allows us to define mechanisms that channel people's motivation and commitment towards the development of tasks in order to promote and accelerate the acceptance of SPI [Dorling and McCaffery 12].

This research paper represents a pioneering and innovative approach and it establishes specific mechanisms that allow the link between gamification and organizational change management in SPI. This link crystallizes in the methodological framework, which, through gamification, aims to increase motivation and commitment in organizational change management for SPI. In this context, we can state that none of the existing SPI motivational proposals (e.g, [Ferreira and Wazlawick 10]; [Ferreira and Wazlawick 11]) have the extension and motivational depth of this investigation and, therefore, this new approach can be considered a disruptive factor within SPI initiatives.

In addition, this research theoretically validates the gamification's CSF for SPI, which represent the main guidelines of the gamification framework. Despite the validity of the most representative guidelines, multiple limitations that threaten the reliability of the validation have been found. For this reason, the possibility of generalizing the results of the validation is limited, and this research must be complemented with a number of action lines that will allow to progress in the right direction. Therefore, in order to strengthen the reliability of the validation, it will be necessary to overcome the described limitations and reduce the level of abstraction when identifying the CSF, including specific game elements and the typical aspects of SPI. However, the novelty of gamification as an object of study limits this type of theoretical validation and requires an empirical validation of this gamification framework in a real software organization that is trying to run a SPI initiative.

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