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Goal Models for Acceptance Requirements Analysis and Gamification Design

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Abstract. The success of software systems highly depends on user engagement. Thus, to deliver engaging systems, software has to be designed carefully taking into account *Acceptance Requirements*, such as "70% of users will use the system", and the psychological factors that could influence users to use the system. Analysis can then consider mechanisms that affect these factors, such as *Gamification* (making a game out of system use), advertising, incentives and more.
We propose a *Systematic Acceptance Requirements Analysis Framework* based on *Gamification* for supporting the requirements engineer in analyzing and designing engaging software systems. Our framework, named *Agon*, encompasses both a methodology and a meta–model capturing acceptance and gamification knowledge. In this paper, we describe the *Agon Meta–Model* and provide examples from the gamification of a decision–making platform in the context of a European Project.

Keywords: Acceptance Requirements · Gamification · Goal Modeling · Requirements Engineering · Human Behavior

1 Introduction

Usage is becoming the main factor that determines the success of a software system [10,11,15], especially so for social software such as Twitter and Facebook. In fact, the human aspect has to be deeply taken into account and addressed by building into a system strategies for stimulating the user to carry out activities that the system supports. For instance, if we consider Facebook, its success resides mainly on people's participation in platform activities. In fact, if people stop posting videos, comments, etc., the entire system would be deemed a failure. Thus, to guarantee the success of such a system, it is essential that users use the functionality of the system [10, 11]. According to this, in order to maximize the usage and participation, favoring the success of a system, it is important to analyze and design a system considering also elements for engaging the user [15]. Such elements have been called *Acceptance Requirements* [10, 11].

Acceptance Requirements and how to fulfill them have been receiving much attention in the literature [3, 5, 10–12, 15]. Fulfilling such requirements calls for expertise such as psychologists, sociologists or marketing experts [11,15], and this makes the design process even more complex, error–prone and time–consuming

than for vanilla software. Unfortunately, few requirements engineering studies and practices consider adequately such strategical concerns [11].

In order to tackle this acceptance requirements problem, we need systematic, tool supported methodologies able to: (i) guide the analyst in properly and accurately analyzing and eliciting *Acceptance Requirements* [10,11]; (ii) support in finding and designing operationalization solutions (e.g., through *Gamification*) [10, 11]; (iii) provide suggestions concerning which psychological (acceptance) strategies and (gamification) best practices to employ in relation to the typologies of users the analyst has to engage (e.g., on the basis of acceptance and gamification knowledge conceptualized and modeled as meta–models) [10, 11]; (iv) reason with the knowledge of conceptual models, mentioned in the previous point, to supply the analyst with proper suggestions [10, 11].

In a previous short paper [10] we propose a preliminary version of *Agon*, an *Acceptance Requirements Framework based on Gamification*. Agon supports all the elements discussed above with a methodology: a *Systematic Acceptance Requirements Analysis* based on *Gamification*. This methodology is founded on and uses a *Multi–Layer Meta–Model* that represents acceptance and gamification knowledge. This paper is an extension of [10], focusing on the *Agon Multi–Layer Meta–Model*. The paper presents a detailed description of the models and examples from a real case study, in the context of a European project, where we employed Agon and its meta–model for gamifying a decision–making platform.

The next sections of this work are organized as follows. Section 2 introduces: (i) the *Acceptance Requirements*; (ii) the European project of the decision–making platform we gamified by using the *Agon Meta–Model*; (iii) how acceptance requirements are important in the context of the previous point. Section 3 provides an overview of the *Agon Multi–Layer Meta–Model* and illustrates in detail the meta–models that compose it. Finally, section 4 concludes.

2 Acceptance Requirements and the PACAS Project

Acceptance Requirements are defined over a set of `Functions`, that are supposed to be accepted, and a target set of users, `Participants`, that must use the functions. Thus, they constitute a special class of quality requirements [6] represented as: `Acceptance[{Functions}, Participants]` $\geq$ `N%`. Each acceptance requirement imposes a constraint, `N%`, on the percentage of intended users actually agree to use the functions. The task for the designers is to deploy psychological, cognitive and behavioral mechanisms to spur users to use the functions.

In the following, we introduce the *Participatory Architectural Change MAnagement in ATM Systems* (PACAS[1]) European project (ATM stands for Air Traffic Management) and explain why acceptance requirements are important in its context (EATMA). The European Air Traffic Management Architecture (EATMA) is composed of many procedures that are continuously discussed, innovated and improved concerning safety, security, organizational and economical aspects. This requires complex architectural change management activities

[1] `http://www.pacasproject.eu/`

involving many heterogeneous stakeholders from various institutions, agencies, and companies. The stakeholders, decision makers having different expertise, to find a solution, deal with many concurrent multidisciplinary variables, needs and constraints coming from different realities. They should collaborate and participate actively to the decision making process for finding an agreement fulfilling safety, security, organizational and economical aspects. Thus, the critical part is to guarantee that all the stakeholders participate actively and continuously to the process for designing high–quality solutions.

This process is enacted by using a platform for managing EATMA architectural changes. Therefore, our aim has been to make the platform able to motivate the stakeholders to participate and collaborate actively. We used the Agon methodology and the Agon meta–model, described in this paper, for analyzing acceptance requirements and operationalizing them for gamifying the platform. The full case study is available at [9]. An extract of acceptance requirements we defined for PACAS is: `Acceptance[{Propose Change Management, Report AsIs Details, Propose Alternative, ...}, Decision Makers]` $\geq$ `80%`. Thus, we identified the set of crucial functions of the platform that need full users' participation to satisfy platform objectives. For instance, from the previous definition, we decided to motivate decision makers, above all, concerning the usage of the platform for proposing a new change management, reporting collaboratively details of the procedures to be improved, finding problems and parts to be enhanced and proposing alternative solutions. By using the Agon meta–model, described in the next section, we refined these acceptance requirements and operationalized them by gamifying functions highlighted above [9].

3 The Agon Multi–Layer Meta–Model

Here, we start giving an overview of the Agon multi–layer meta–model and, in the next sub–sections, we describe each model composing the entire meta–model.

The Multi–Layer Meta–Model. The *Agon Multi–Layer Meta–Model* is shown in Fig. 1 with an example from the PACAS case study. The example is described step by step in the next sub–sections. The meta–model is composed of 4 abstraction layers and at each level there is a goal model [2]. In order to design the Agon meta–model, we extended the *NFR Framework* [2], and in the following sub–sections we describe all the elements at each layer. At the moment of writing, the meta–model counts 281 goals and 393 relations. It represents the acceptance and gamification knowledge and, we are continuously improving it by adding new elements. This is necessary because new acceptance and gamification concepts have been continuously appearing in the literature, thus, it is important to apply updates for keeping the meta–model as much as possible close to the reality and, therefore, precise and effective.

From the acceptance level to the gamification level (Fig. 1) we have the *Acceptance Meta–Model* (AMM), the *Tactical Meta–Model* (TMM) and the *Gamification Meta–Model* (GMM)). Them are meta–models including generic concepts

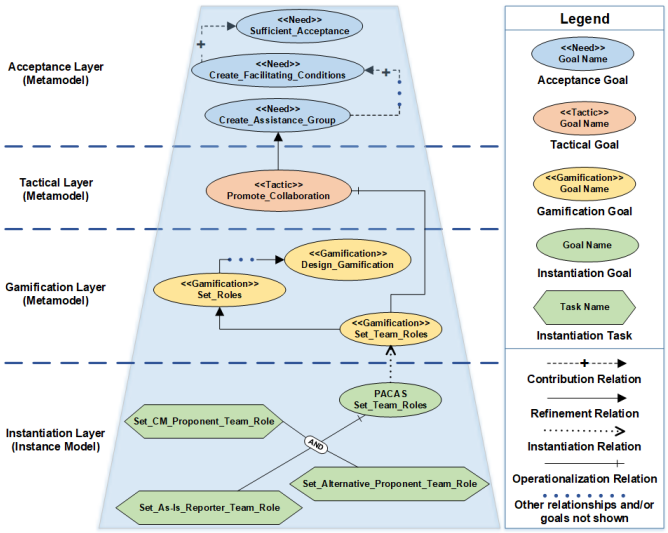

Fig. 1. The Agon multi–layer meta–model

not referring to a particular domain (e.g., the one of PACAS). In fact, them are composed of: (i) psychological strategies (AMM); (ii) tactics (TMM) as high–level goals AMM and GMM have in common; (iii) gamification solutions (GMM). In the bottom layer, there is the *Instance Model* (IM). IM is not a meta–model, it instantiates generic goals of the upper level (GMM) by specifying them in relation to the distinct domain of the system to gamify (e.g., PACAS).

The requirements analyst, following the Agon methodology, a *Systematic Acceptance Requirements Analysis based on Gamification*, uses the Agon meta–model starting from the top, the most abstract layer (AMM), and going towards the bottom layers (GMM and IM). This activity is semi–automatic because, at each layer, the analyst uses reasoning techniques applied to goal models [7] and automatically receives suggestions related respectively to acceptance, tactical and gamification solutions to employ in the gamification of the system. This activity is also interactive, because the analyst at each layer, on the basis of suggestions received and her knowledge regarding the domain of the system to gamify, takes further decisions (e.g, discarding parts of the solutions proposed).

Morever, Agon is composed also of another fundamental model, the *User Context Model* (UCM) (designed with *Context Dimension Trees* [8]), that characterizes the intended users to engage through context variables such as gender, age, expertise, kind of player [1], etc. These variables are crucial elements used during the reasoning activity described above. Indeed, relations of the Agon models are annotated by *Context Dependent Rules* (CDRs) defined on UCM variables. CDRs are evaluated to decide if to keep or discard some relations and connected elements. The idea behind this, is to reason over acceptance and gam-

ification knowledge, the meta–model, selecting the solutions (goals) that are the most suitable ones for the users to motivate.

In the following sub–sections, we describe all the Agon models by providing some examples from the PACAS case study. The complete case study, the Agon meta–model (with full models) and the Agon glossary can be found online at [9].

The User Context Model. Different people are stimulated by different psychological factors and gamification solutions [1, 5, 14, 15]. This is captured by UCM that includes users' characteristics to consider for the selection of acceptance and gamification strategies that can affect positively a specific kind of user. Thus, the analyst instantiates UCM on the basis of the user's characteristics and, when Agon executes reasoning over AMM, TMM and GMM, considers the UCM instantiation for evaluating CDRs (annotated in the relations of the models) to select the most suitable solutions for the intended users. CDRs are rules (we extracted them from the literature [1,5,14,15]) composed of expression based on the UCM variables. For example, in Fig. 2 there is an extract from the meta–model specifying that: (i) if you are dealing with socializers (or other user's kinds expressed by the CDR starting with `(C2[Socializer] OR ...`) challenges tackled in team (`Team Challenges`) are preferred [15]; (ii) if you are dealing with males or achiever, etc., (`((C7[Male] OR C1[Achiever] ...`) personal challenges (`Personal Challenges`) are suggested [15].

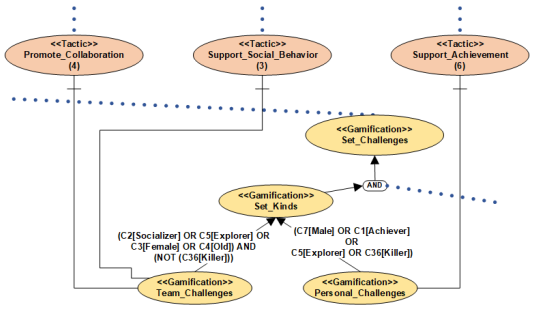

Fig. 2. Context dependent rules, gamification goals and tactics

The Acceptance Meta–Model. AMM is composed of *Needs* (legend in Fig. 1) to be satisfied for maximizing the possibility that intended users accept to use the system. We designed AMM by carrying out a wide literature review of technology acceptance models (e.g., the Unified Theory of Acceptance and Use of Technology (UTAUT) [14], the Technology Acceptance Model (TAM2), etc.; full list in [10]) and merging the most relevant concepts in a model, the Agon AMM.

The main structure of AMM (Fig. 3) and related CDRs are based on the UTAUT model [14]. The root goal is the `Sufficient Acceptance` need. It is the most abstract goal and it means to make that most of the intended users accept

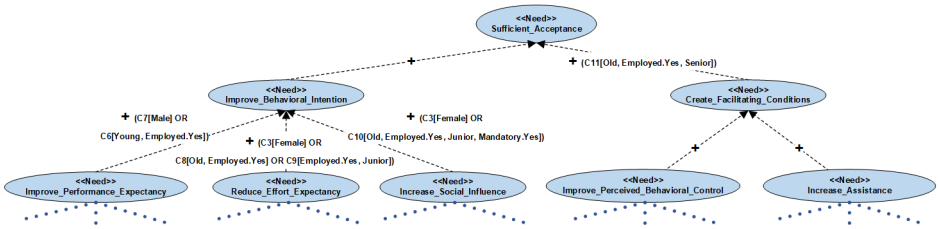

Fig. 3. An extract of the Agon acceptance meta–model based on UTAUT [14]

to use a software. This receives positive contributions (all the relations in AMM are contributions) by two high–level needs (Fig. 3): (i) `Improve Behavioral Intention` that in turn receives positive contributions from `Improve Performance Expectancy`, `Reduce Effort Expectancy` and `Increase Social Influence`; (ii) `Create Facilitating Conditions` that in turn receives positive contributions from `Improve Perceived Behavioral Control` and `Increase Assistance`.

Around the main high–level needs we inserted relevant concepts of other technology acceptance models. For instance, needs that provide positive contributions to `Increase Assistance` come from [13]. Those needs are not shown in Fig. 3 for the sake of space, but we can refer on the example from PACAS in Fig. 1, where it is shown one of them: `Create Assistance Group`. In fact, the idea is that, in order to create facilitating conditions for the decision makers of PACAS, Agon suggested to organize their activities in virtual groups for increasing the possibility of supplying assistance each other.

The Tactical Meta–Model. On the one hand, AMM is composed of abstract psychological factors. On the other hand, GMM includes more concrete (though still generic, i.e. not domain–specific) elements such as gamification solutions. Thus, it is needed an intermediate layer to fill the gap between the two (Fig. 1). With this aim, we designed TMM (Fig. 1) by selecting common high–level qualities able to tie acceptance and gamification goals. According to this, acceptance needs are refined by *Tactics* (goals at the tactical level) that in turn are operationalized by gamification goals (Fig. 1). Continuing the example in Fig. 1, at the AMM level Agon proposes to enable users to assist each other in groups and, at the tactical level it is refined by promoting collaboration (`Promote Collaboration`) among the PACAS decision makers. This leads Agon to select gamification goals able to operationalize the collaboration promotion (we discuss this in the next sub–section). Other tactics are shown in Fig. 2.

The Gamification Meta–Model. GMM is built on gamification concepts and best practices we extracted by carrying out a wide review of the literature and of success cases from the industry (some resources [3, 4, 12, 15]). GMM supports mainly: badges, levels, paths, leader–boards of various kinds, redeemable points, reputation points, experience points, karma points, skill points, gamified trainings, gamified tutorials, game roles, unlockable powers, gamified tours, avatars,

suggestions and tricks, gamified forums, team and personal challenges, gamified communities and gamified markets with redeemable rewards and making gift policies.

The main relationship used at the GMM level (Fig. 1 and Fig. 2) is that of refinement. Furthermore, gamification goals operationalize or give positive/negative contributions to tactics (Fig. 2). For instance, the challenges concept is represented in Fig. 2 (`Set Challenges`) with: `Team Challenges` and `Personal Challenges`. According to the CDRs indicated, team challenges are suggested for socializers, explorers, etc., and them operationalize the `Promote Collaboration` and `Support Social Behavior` tactics. Continuing the PACAS example in Fig. 1, at the tactical level Agon suggests to promote collaboration and, at the gamification level, it is operationalized by arranging teams and team roles (`Set Team Roles`) for PACAS decision makers.

The Instantiation Model. Solutions obtained at the gamification level are the result of acceptance and tactic reasoning and are the most suitable for the intended users, but are generic, independent from a specific domain. Therefore, GMM goals need to be instantiated in relation to the specific domain of the system to gamify. So far, the process is semi–automatic and interactive, while at the instantiation level the analyst has to create the IM. Agon helps the analyst by providing her with a notation based on the *NFR Framework* [2] supporting goals, tasks, and relations such as instantiations, refinements and operationalizations. Concluding the example from the PACAS case study (Fig. 1), at the gamification level, Agon suggests to operationalize the collaboration through the definition of teams and team roles for the users. This suggestion is valuable and suitable for the intended users, but it is still abstract, thus, the analyst creates the IM (Fig. 1) by instantianting the `Set Team Roles` gamification goal and defining the purposes of each team roles. Those purposes are specific of the PACAS domain. For instance, `Set As-Is Reporter Team Role` defines a team responsible for reporting the current as–is situation of an ATM procedure. While, `Set Alternative Proponent Team Role` describes a team in charge of proposing alternative solutions for improving an ATM procedure.

4 Conclusion

In this paper, we focus on a fundamental component of our Agon framework, the *Agon Meta–Model*. It captures acceptance and gamification knowledge and facilitates a systematic acceptance requirements analysis based on gamification. Moreover, we have provided examples from a real case study that we conducted in the context of the PACAS European project[2]. This case study concerns the gamification of the PACAS platform by using Agon. Moreover, preliminary evaluations conducted with non–experts (master students) and experts (experts on gamification and requirements engineering from the PACAS project) confirmed

[2] `http://www.pacasproject.eu/`

the usefulness of Agon. In order to collect more evidences regarding the Agon usefulness, we are employing Agon also in the context of other European projects, for instance in the Vision project[3] for gamifying a privacy platform.

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