Gamification Solutions for Software Acceptance: A Comparative Study of Requirements Engineering and Organizational Behavior Techniques

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Abstract—*Gamification* is a powerful paradigm and a set of best practices used to motivate people carrying out a variety of ICT–mediated tasks. Designing gamification solutions and applying them to a given ICT system is a complex and expensive process (in time, competences and money) as software engineers have to cope with heterogeneous stakeholder requirements on one hand, and *Acceptance Requirements* on the other, that together ensure effective user participation and a high level of system utilization. As such, gamification solutions require significant analysis and design as well as suitable supporting tools and techniques. In this work, we compare concepts, tools and techniques for gamification design drawn from *Software Engineering* and *Human* and *Organizational Behaviors*. We conduct a comparison by applying both techniques to the specific Meeting Scheduling exemplar used extensively in the Requirements Engineering literature.

Index Terms—Requirements Engineering, Organizational Behavior, Acceptance Requirements, Gamification, Human Behavior

I. INTRODUCTION

Gamification is a design technique that makes a game out of using a software system in order to enhance user experience thereby encouraging its user acceptance. Over the last decade, gamification has been drawing growing interest among scholars and practitioners in many fields [1]. Indeed, gamification has been considered as a useful tool to enhance participation, social interaction, motivation and performance when certain software–intensive activities and tasks are carried on. As such, gamification has been applied widely to many heterogeneous fields, among others collaborative activities [2], education [3], urban mobility [4] and software engineering [5].

Most of the successful gamification solutions offer users a gamified experience, typically by using mobile and web applications or, in some cases, also through other IT technologies [6]. Thus, building a gamification solution means to carry on a complete software engineering process delivering a gamified software solution. In general, such software engineering requires complex, difficult and error–prone activities requiring specialized expertise, beyond what is expected by your average software engineer.

Therefore, an increasing amount of studies regarding *gamification engineering* (software engineering of gamification solutions) have been proposed [4], [7]–[9], aiming to improve the process, making it more systematic. A huge effort has been undertaken to develop *Gamification Frameworks* (also called platforms, engines or systems). A *Gamification Framework* is a software system that supports the analyst/designer/developer during software engineering activities (e.g., analysis, design, development) by applying gamification to a system and by offering well–established gamification procedures and ready–to–use tools.

An important criterion for the success of a software system consists of measuring the degree of acceptance of the system by its intended user community. Thus, *Requirements Engineering* (RE) and, above all, the elicitation and analysis of user requirements and acceptance requirements [7] are key phases towards the creation of a gamified software [10] aimed at involving and motivating users. In fact, right from the early phases of gamification engineering, it is fundamental to conduct an accurate and extensive analysis concerning the most important variables needed to design a successful gamification solution. According to the literature, this is not systematically done by practitioners, resulting in less accepted software than what its owners had hoped for [11], [12]. Gamification fails when people are not engaged and it is directly correlated to the fact that *human factors* are not adequately considered in the gamification process and, above all, during the crucial phase of RE analysis. Therefore during the analysis, the most important variables concern *Human Behavior* and related context. By extensively analyzing gamification, behavioral, cognitive, psychological, social/economic studies [2], [3], [11]–[15], we derived important variables (Fig. 1) that are related to the characterization of:
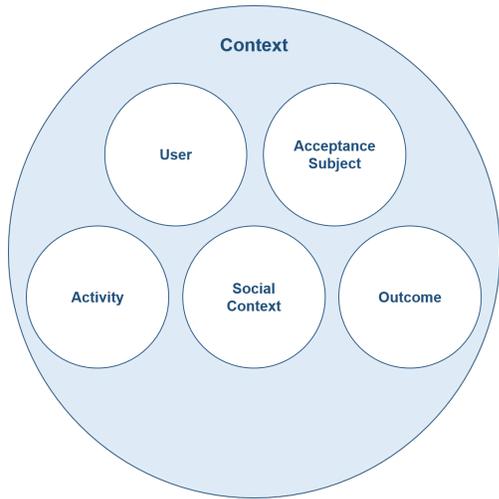
- the User to engage;

Fig. 1. Context variables relevant for the gamification requirements analysis

- the `Acceptance Subject`, which is the software to be used (focusing on the perspective of the user);
- the `Activity` to carry out by using the software and related variables from the perspective of the user;
- the `Social Context`, the set of social relations in which the software is used;
- the `Outcome` produced by using the software, especially, user expectations and how the user is affected by the outcome.

These variables are the starting elements to be considered before designing any gamification solution, they can be unveiled during the RE phase and are important for all gamification phases. On the basis of those variables, another fundamental activity that should be carried out, in order to maximize the chances of success of the gamification solution, is to analyze and select psychological strategies and gamification best practices that can positively affect human behavior vis–a–vis acceptance.

In summary, in order to produce an extensive high–quality gamification solution from acceptance requirements, the following activities need to be conducted:

1) analysis and characterization of context variables;
2) analysis, selection of psychological/cognitive strategies for stakeholder acceptance requirements;
3) analysis and design of gamification best practices for the problem–at–hand.

In the scientific literature and in the software development market, there are still important gaps regarding the existence of tools for supporting the analyst in applying gamification systematically during the RE process. In order to cover these gaps, two different frameworks have been proposed in previous works and are carefully compared in this paper: *Agon* [7] and the *Motivational Antecedents Framework* (MAF) [2], [16].

Agon [7] has been developed in the RE field, intended to support the gamification phase (activities 2 and 3 above), including the characterization of the *User* and the *Acceptance*

Subject (activity 1).

The *Motivational Antecedents Framework* (MAF) [2], [16] has been developed in the field of *Organizational Studies*, intended to support the analysis of human behaviors in physical and organizational contexts. There is a huge field of studies on human behaviors, motivations and incentives in organization referred to as *Organizational Behavior* since the pioneering work of Mayo and his famous "Hawthorne and the Western Electric Company" case study [17] in 1930. Even though MAF has not been designed with an engineering perspective, and its methodology is largely organizational studies–based, it can support the RE analysis phase analogously to Agon. Even though MAF was conceived in a field far away from RE, it has been used as a gamification framework to develop a set of incentives embedded and implemented in IT solutions.

We envision that MAF (covering activity 1 above and the *Activity*, the *Social Context* and the *Outcome* context variables of Fig. 1) and its methodology constitute an excellent candidate for comparison with Agon, to understand areas of similarity and difference in the concepts and techniques they use to support gamification. The description of these frameworks and all the related considerations are extensively discussed in the next sections.

The main objectives of this paper are:

1) the analysis and comparison of two different frameworks, Agon and MAF, and their methodologies;
2) the definition of preliminary guidelines for integrating the two frameworks in a comprehensive framework.

Due to the remarkable dissimilar origin of the two frameworks and respective methodologies, the comparison and guidelines provided by this study are valuable prerequisites for extending Agon to produce a holistic framework that encompasses engineering, behavioral, cognitive/psychological and social/economic concerns. We conduct the comparison by applying the two frameworks to gamify a meeting scheduling software system example as a simple case of social software that comes with acceptance requirements and needs to be gamified.

The rest of this paper is organized as follows: section II briefly recaps the literature on gamification and software engineering applied to gamification. Section III analyzes the two frameworks adopted in this work. Section IV applies such frameworks to the meeting scheduler exemplar showing the two methodologies in action. Section V presents and discusses results of the comparison, while section VI provides preliminary guidelines for integrating the frameworks. Finally, section VII concludes and outlines future work.

II. RELATED WORK

Gamification applies design concepts of games in non–game contexts [11]. In recent years, gamification has been exploited for software systems and apps in different domains with positive results [1], [4]. In fact, both practical experiences from the market and studies from the literature, confirm that gamification can be very useful in very heterogeneous sectors and for various aims [1]. The process of applying gamification

to an IT system can be referred to gamification engineering activities. Many gamification tools such as gamification frameworks and related studies [4], [7]–[9] recently appeared to reduce the complexity and resources needed by those difficult activities.

The gamification frameworks available on the market, besides their advantages, have still important limitations [9]. Most of them are not flexible and generic enough to be successfully applied to a variety of cases, mainly because they are domain–specific design (e.g., Youtopia focuses only on education), support only a reduced set of gamification concepts (e.g., UserInfuser and Mozilla Open Badges) [8], and are quite limited in their expressiveness to design a significant variety of gamification scenarios. Another limitation is due to the dependence on third–party environments in relation to configuration, implementation, maintenance or run time aspects, such as most of the platform illustrated in [8].

In the literature there are still a few (but increasing in numbers) studies that try to overcome the limitations of existing frameworks, thus that topic appears to open new research directions. Some researchers propose generic gamification engineering approaches and generic frameworks that are more flexible and employable in a wider range of cases [4], [8], [9]. Herzig et al. [8] present a prototype gamification platform for enterprise information systems and business–to–business integrated systems based on an event–driven architecture. Kazhamiakin et al. [4] developed an extensible service–oriented gamification engine and tested it successfully in a field case study concerning motivating citizens to use sustainable urban transports. Sripada et al. [9] describes a generic, extensible framework for modeling gamification concepts as modules able to expose RESTful web services. They defined a service–oriented architecture able to integrate and extend already existing gamification services. Their study aims at gamifying software engineering tasks.

Gamification frameworks mentioned earlier provide support regarding gamification design and development activities. As far as we know, the only framework able to support the analyst in the requirements elicitation and analysis phases for applying gamification to a system is Agon [7]. Agon is an *Acceptance Requirements Framework* where the designer takes into account the kind of user/player to engage and select the most suitable psychological/cognitive strategies and gamification concepts to employ to produce an effective gamified solution. Agon is founded on the premise that gamifications are solutions to *Acceptance Requirements* [7] that stakeholders have about a system–to–be. Sometimes acceptance requirements are also called in the literature *Usage Requirements* or *User Acceptance Requirements*. Agon is one of the two frameworks we compare in this work and it is discussed in greater detail in the next section.

Human and *Organizational Behavior Studies* have proposed theories and best practices for the analysis of human–technology interactions that can serve as foundations for the design of systems that promote user participation. Moreover, motivational factors have been studied in *Organizational Studies*, *Experimental Economics*, *Sociology*, and *Political Science* since the 1930s [17]–[20]. In the last decades, various studies have focused on user motivational factors, human willingness to participate in a process, and best practices (*Mechanism Design*) for encouraging participation. The terms, the epistemologies and the languages used in organizational studies are very different than those in RE studies, but the subject of analysis is almost the same. These studies reveal that the inner motivations that drive people to participate are heterogeneous and strongly influenced by the uniqueness of each action. Some regularities can be identified and motivation can be categorized as: needs of reciprocity, reputation, competition, conformity to a group, altruism, self esteem, fun and personal enjoyment, implicit promise of future rewards, and money [16], [21]. Nowadays some of these factors can be profitably used as antecedents to identify incentives, best practices and game mechanisms that spur individuals to act in accordance with a specific goal.

In previous work, an extensive analysis of various studies on motivation have been conducted from an *Organizational Study* perspective, and some variables have been identified as ones that influence contributor/worker performance [2], [16]. These variables are described in the other framework we use in this study, the *Motivational Antecedents Framework* [2], [16].

III. Baseline: The Agon and MAF Frameworks

In this section we present two different frameworks, the first is grounded in cognitive science and RE, the second in human behaviors and organizational behaviors. In section IV, these are applied to the meeting scheduling exemplar.

Agon: an Acceptance Requirements Framework. Agon [7] offers concepts, tools and techniques for systematically designing gamified solutions for acceptance requirements. These solutions take into account cognitive aspects able to affect positively particular kinds of users. This can be especially useful in the context of social software systems, where it is essential to motivate user participation in system activities. Accordingly, Agon guides and supports the requirements analyst to analyze *Acceptance Requirements* [7], and select for them a gamification solution.

Fig. 2 shows the abstraction layers of the framework (with sample elements for each layer) and in the sequel we describe the models that reside in each layer.

Principal elements of the framework [7] are two goal models: a generic *Acceptance Model*, at the *Acceptance Layer* (Fig. 2), and a generic *Gamification Model*, at the *Gamification Layer* (Fig. 2). The first one represents the problem space offering refinements for acceptance requirements that include psychological factors that contribute to system acceptance. The second one captures gamified operationalizations for acceptance requirements as gamification elements and design patterns.

Agon also includes a *Tactical Model* (Fig. 2) that acts as a bridge between the two worlds of acceptance and gamification. In fact, the tactical model covers the gap between acceptance
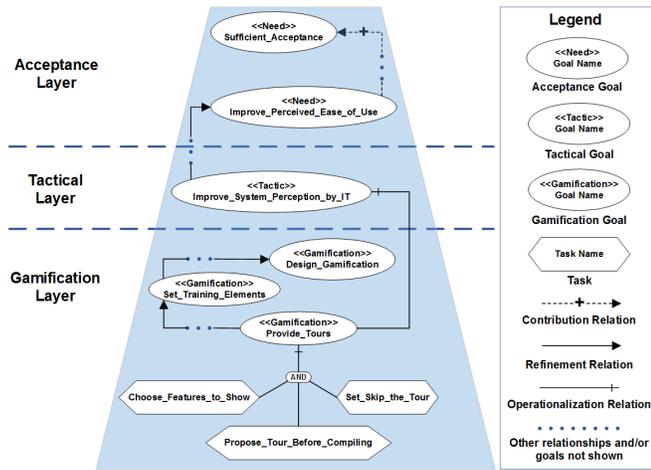
Fig. 2. Abstraction layers of Agon with a simple example [7]

and gamification models and, at the same time, makes it possible to decouple them. Moreover, the tactical model offers further refinements (named tactics) for acceptance requirements and links them with gamification goals.

The three models are located at different abstraction layers (Fig. 2). At the acceptance layer there are psychological needs that can be refined by tactics located at the tactical layer, and these can be operationalized by the more concrete goals that constitute the gamification layer.

Moreover, different kinds of people are motivated effectively by different kinds of gamification strategies [12]–[15]. This concept is captured by a *User Context Model* and *Context Dependent Rules* (CDRs). Dimensions of the user context model are user characteristics related to common aspects (e.g., gender and age), gamification aspects (e.g., player types such as socializer, achiever, explorer, killer) and acceptance aspects (e.g., expertise and familiarity regarding the proposed system). CDRs associate those dimensions with the most pertinent acceptance and gamification concepts for representing best strategies able to improve user involvement depending on the user characteristics. Moreover, the acceptance and gamification models are annotated by these rules in order to support reasoning over them for selecting most suitable strategies to engage the intended group of users.

Agon models are generic reference meta–models, because they do not refer to a particular domain and can be applied to a variety of domains. They are composed of 270 goals and 376 relationships of different kinds and have been continuously growing and evolving in dimension and quality by adding new psychological factors, gamification concepts and best practices [7]. The models were designed by extending the *NFR Framework* [22] and the user context model by extending *Context Dimension Trees* [23]. Complete models and a glossary (concerning elements of the Agon Framework) are respectively available online at [24] and [25].

The *Acceptance Requirements Process* can be summarized as follows. The requirements analyst characterizes the intended

group of people to motivate by referring to the user context model. Agon, on the basis of the user characterization chooses psychological factors that best fit by using the acceptance model. These factors are refined by tactics of the tactical model that in turn are used by the framework for selecting most suitable gamification concepts and best practices. On the basis of selected elements, Agon provides the analyst with a gamified solution. Moreover, the process can be interactive because the analyst can make decisions, during all the phases, concerning intermediate and final solutions proposed by Agon.

In this paragraph, to explain the process with sample elements, we provide an example (Fig. 2) where we illustrate a very simplified version of the complete case study we describe in section IV. The case study concerns how to stimulate users of a Doodle–like meeting scheduler to indicate their preferred dates for scheduling a meeting. First of all, the analyst characterizes the intended group of people to convince: senior employed males that are achievers as kinds of players, they are not experts regarding using Doodle or similar software, it is not mandatory for them to fill the Doodle and they have not scheduled meetings by using IT systems previously. Agon, on the basis of the characterization proposes to take into account the Reduce Effort Expectancy acceptance need, because there is a rule annotating it saying that elders are influenced positively if that need is satisfied [15]. Agon chooses Improve Perceived Ease of Use (Fig. 2) as need that can contribute positively to the previous one, and as refinement of it the Improve System Perception via IT tactic (Fig. 2). Finally, it individuates as operationalization of this tactic a gamified training element that is Provide Tours (Fig. 2). Thus, the gamified solution is to motivate elders making them aware using Doodle requires low efforts, by improving their perception of it through a gamified IT solution: a gamified tour showing how to use Doodle. Concluding the example, because Agon models are generic reference meta–models and do not refer to a particular domain, the analyst has to instantiate the tour with elements specific of her domain, the meeting scheduler. Thus, she adds final tasks [22] (activities that can be executed by a person or the system–to–be fulfilling the upper goals) for indicating the features to show in the tour concerning the usage of Doodle (Choose Features to Show in Fig. 2), for proposing the tour before compiling (Propose Tour Before Compiling in Fig. 2) and the possibility to skip the tour making it an optional feature (Set Skip the Tour in Fig. 2).

Motivational Antecedents Framework. MAF derives from a study based on *Organizational Science* and *Game Theory* [26]. The basic idea here is that success of an IT solution requires a blend of well designed software (i.e., usability) and carefully crafted policies aimed at achieving user participation. Moreover participation strongly depends on the inner motivation of participants. A number of studies on organizational theories have concluded that motivation can be the result of heterogeneous reasons, and might result from incentives offered to the

performer or from intrinsic desire. Motivation is intrinsic if the performer enjoys the act of performing the task *per se*. In all other cases, a set of extrinsic incentives can be provided in order to make an individual/team perform. Incentives are a set of instruments (e.g., money, reputation, rewards, prices, credit points, medals) assigned by an external "judge" according to an evaluation of the effort exercised by the performer. In principle, these can be totally uncorrelated to the nature of the task.

In order to achieve a satisfactory level of participation a set of methods and techniques have been adopted, often referred to as mechanism design in the field of economics, that can be used to develop incentives, which can be embedded into IT solutions (as in a gamified solution) [21]. *Mechanism Design* is a field of game theory developed in economics that studies the effective design of rules for human behavior. If individuals follow these rules, they achieve the outcome desired by the game designer. The underlying hypothesis is that individuals act according to their own private interests and only a careful development of appropriate incentives can enable the alignment of individual and social interests. To develop a set of incentives from the *Mechanism Design* perspective, developers need to understand the social environment (the context) and codify its constraints in game theory terms [26].

MAF focuses on sociability design [27] and in particular on the first two phases of the software development process: the analysis of the use scenario prior to application design and the fine tuning process of the incentive structure.

MAF is based on four main variables that play an important role in influencing the performance of actors [2], [16] (Fig. 3). The four variables are: (i) Goal of any activity; (ii) the set of Tasks a person has to carry on in order to pursue the goal; (iii) the Social Structure within which the actor acts (a team of peers, a company, a community); (iv) the Nature of Good being produced (public, club or private good). These are represented in Fig. 3 and briefly summarized below.

Goal		Tasks		Social Structure	Nature of good being produced
Communication level (about the goal)	High	Variety	High	Hierarchy-neutral	Public good (non rival, non exclusive)
	Medium		Medium		
	Low		Low		
Participation level (in defining the coal)	High	Specificity	High		
	Medium		Medium		
	Low		Low		
Clarity level	High	Identification	High	Hierarchical	Private good (rival, exclusive)
			Low		
	Low	Required skills	High specificity		
			Triavial common		

Fig. 3. The Motivational Antecedents Framework and its context variables

The Goal is what people want to pursue and their aspiration to achieve it. Three main elements shape the pursuit of a goal by a group of people:

- the communication level about the goal. This element determines the kind of communication that exists among participants. A low communication level implies that the goal is not clearly defined and communicated;
- the participation level of actors. This element is key to understand the role of actors in defining the goal to be achieved;

- the clarity of the goal. This element identifies whether and to what extent the goal to achieve is clear to the actors.

These three elements shape the aspiration level of actors in achieving a goal. For instance, a designer might raise the aspiration level of the player by means of intensive communication and participation, through which individuals understand and redefine the goal, getting more and more committed. So, a reasonable difficulty level significantly correlates with motivation and how much effort and persistence individuals will exert to achieve their goals [28], [29].

The Task refers to the set of actions actors have to carry out in order to achieve a goal. Various elements affect individuals' inner motivations that, in turn, influence their performance in terms of quality and speed of performed actions. These elements are:

- Variety. Refers to the multiplicity of activities needed to perform the job. It correlates positively with individuals' competencies and ability to coordinate multiple activities and adapt to change;
- Specificity. Refers to the level of knowledge uncommonness required for the task;
- Identification. Refers to the extent to which people perceive a job as a complete set of steps that lead to clear results [30] individuals tend to appreciate being able to produce a meaningful outcome that is identifiable as their own;
- Required skills. It is the set of knowledge and competences required to carry out the tasks. As much as the required skills are meaningful the motivation of participants is crucial.

The Social Structure denotes a set of relationships that occur among individuals involved in pursuing a goal. Social norms have a strong influence on the channels of communication, coordination mechanisms, beliefs and views, feelings, and motivations that affect these relationships [31], [32]. The social structure might be summarized in two main scenarios. The first scenario is that of the social structure being a hierarchical organizational. This means that there is a hierarchy among people working within the organization. It also means that the relationships among people may be affected by the so called *Principal Agent* relationship in which the principal delegates an agent to deal with a specific task. In this case the agent has the obligation to deal with the task and the principal needs to control it (as in a employer–employee relationship). In hierarchical neutral organization there is no formal obligation among actors; participants are thus a group of peers.

The Nature of the Good describes the relationship between the producer and consumer of the good. Private goods are excludable and rival, namely a specific user can take exclusive advantage of it (consumers might have to pay to use it). By contrast, public goods are neither rival nor excludable. Namely, as soon as they are created any individual can use them, and nobody can be excluded. Typically, if the good is

private the creator wants to be payed for it, while if it is public the creator creates it for free as a "noble" cause.

As explained in [21], the ideal process of design and development of an incentivized (gamified) application should start from an analysis of the concrete situation. The field analysis is crucial to identify the motivations of both individuals and the social groups they belong to. Direct observations, interviews and questionnaires are very effective techniques that can be used to unveil and better define the crucial elements discussed earlier. Then, mechanism design, as a set of techniques, allows the modeling of the situation by using game theoretical predictions about the behaviors of the actors described in the model. Given a set of goals, this model enables the analysts to design a set of incentive schemes that would spur users to behave in line with desired outcomes.

IV. CASE STUDY

In order to conduct our case study, for showing the two different frameworks and methodologies in action, we use the *Meeting Scheduler Exemplar*, a well–established exemplar used in the *Requirements Engineering* research. To focus on game mechanics, motivational factors, and other incentives that spur people to coordinate via ICT tools, we propose a *Doodle–like version* of it. In the meeting scheduler exemplar, as in most of social software systems, participation is a critical requirement, since lack of participation renders the system a failure.

In the following, we first present a concrete version of the exemplar, then apply the two frameworks for purposes of gamification.

Doodle–Like Meeting Scheduler Exemplar and Intended Users. The system to gamify, in this case study, is the Meeting Scheduler Exemplar adapted to Doodle [7]. It is illustrated in [24]. In summary, the requirements for this meeting scheduler include scheduling of meetings, after taking into account participant constraints. In addition, the system should be used by the majority of intended users. Specifically, they should use a Doodle table to input their time constraints for the period when the meeting is to be held.

In addition, we need to characterize intended characteristics of the users and the social context in which they act. The scenario used in this case study is a meeting scheduled for full professors at a university. As it may happen in various universities, the group of people for this case study is composed mostly of senior male professors and achievers as potential players [14]; the users are not experts regarding use of Doodle or similar software, and it is not mandatory for them to fill the Doodle.

Using Agon. To start with, the requirement about scheduling meetings as modeled as a root–level goal that is refined several times to explore alternative ways of fulfilling the goal. The resulting goal model is shown in [24]. Next, we consider the acceptance requirement `Convince Participants to Compile Dates` and the user characterization defined

by means of the Agon user context model (Fig. 4). In the following paragraphs, we describe the phases of the process [7] applied to our case study and sketch some of the steps. In the last paragraph, we provide a summary of the complete gamified solution [7], [24] obtained by employing Agon. In each phase, the analyst can decide whether to accept suggestions generated by Agon using the Agon model glossary [25]. The generation of suggestions by Agon is currently being simulated manually, as the Agon tool is under development. For the future, we envision a reasoning tool based on Constrained Goal Models [33] that selects optimal gamification solutions for a given set of acceptance requirements and a context.

The first phase regards context–based reasoning over the acceptance model. It is context–based reasoning, because it takes into account the user characterization provided and the rules annotating the acceptance model. For example, `Increase Social Influence` is effective if you are dealing with females [15] and since we are dealing with males, this option is not considered. Instead, Agon selects `Reduce Effort Expectancy` because there is an annotated rule saying that elderly users are influenced positively if that need is satisfied [15]. The analyst confirms another proposed need, `Improve Perceived Ease of Use`, because it can supply the user with an introduction to the tool, which is sufficient for Doodle. Accordingly, the analyst discards `Improve Skills` because this requires extensive training beyond what is needed for learning to use Doodle.

Then, there are decisions to be made at the tactical and gamification levels of the framework involving interactively the analyst. `Improve System Perception via IT`, `Support Achievement` and `Improve Perceived Status` are tactics suggested by Agon that can satisfy the acceptance requirement. The analyst confirms all of them. The framework suggests other particular tactics, related to gamification aspects, that do not guarantee to solve the acceptance problem, but can improve the gamified experience of the user. For instance, the analyst selects `Increase User Surprise`, `Support User Penalization` and related tactics.

The next phase regards context–based reasoning over the gamification model. It is context–based, because it takes into account user characterization and the rules annotating the gamification model [24]. Moreover, the gamified solution produced by Agon is computed by selecting gamification elements able to fulfill acceptance and tactical requirements selected in previous phases. For example, because of the rule that says that when dealing with elders it is better to use publishable badges instead of private ones, because they operationalize `Support Social Behavior` [7], which is desired by elders, and the `Set Publishable` gamification goal related to badges operationalizes one of our confirmed tactic (`Improve Perceived Status`), Agon selects `Set Publishable`. Furthermore, the analyst can take further decisions over the suggestions generated automatically by the framework. For instance, she can keep gamification goals, remove some of them or even add new goals and tasks
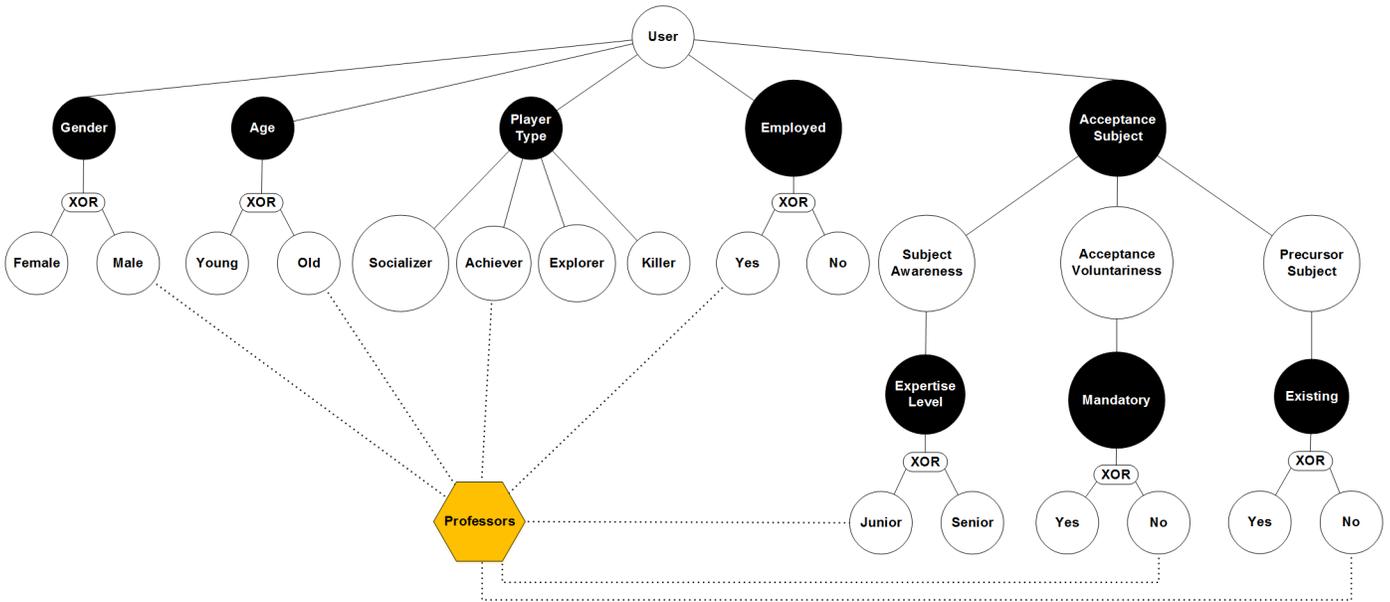
Fig. 4. The target group of users of the case study defined by instantiating the User Context Model of Agon [24]

(hexagons in [24]) as shown in the next phase.

The last phase is the gamification instantiation made by the analyst over the gamified solution produced by Agon. It is important because Agon models are generic reference meta–models that do not refer to a particular domain. Therefore, it is the responsibility of the analyst to adapt the valuable gamification solution generated to the constraints of her domain. For instance, the analyst changes the way leader–boards are computed. In fact, even thought Agon suggests to calculate them on the basis of points, a generic best practice, the analyst prefers a more precise solution: to reward the first users that indicate their favorite dates. Therefore, for instantiating her decision, the analyst substitutes `By Points` with `By Compiling End Time` as task for fulfilling the `Set Leader-boards Calculation Strategy` gamification goal.

In summary, the gamified meeting scheduler [24] includes gamified activities: have an optional (`Set Skip the Tour feature`) tour (`Provide Tours`) offered before filling the Doodle (`Propose Tour Before Compiling`), or fill the Doodle winning a badge (`Set Potential Participant Badge`) and 10 redeemable points (`Set 10 RP`). At the acceptance level, the analyst has discarded the `Improve Skills` acceptance need, because it would have led to unnecessary training solutions. In contrast, the training solution generated by Agon, `Provide Tours`, meets the expectation of the analyst to give the user just an introduction to Doodle, thereby satisfying the `Improve System Perception via IT` tactic, which in turn fulfills the `Improve Perceived Ease of Use` need, both confirmed by the analyst in the process phases. If the analyst would want an intensive training, she can select the `Improve Skill` acceptance need, refine it with the `Support Skill Improvement` tactic and operationalize

the latter with `Define Training Paths`, which needs `Provide Tutorials` that leads to create hard learning paths. Then, the first 3 players that compile the Doodle are winners in the podium (`Set Traditional Podium`) of the leader–board (`Set First Doodle Compilers LB`). Here, the idea is to stimulate people to fill the Doodle as soon as possible. This concept is emphasized also by the fact that these winners are awarded redeemable points and badges. In fact, the first wins `Set First Compiling Badge` and `Win 10000 RP Points`, the second `Set Second Compiling Badge` and `Win 1000 RP Points`, the third `Set Third Compiling Badge` and `Win 100 RP Points`. Redeemable points collected can be redeemed in a gamified market (`Set Market`) with tangible rewards (`Add Tangible Rewards`) on the basis of market rules (`Set Market Policies`) designed, especially redeeming rules (`RP Define Exchange Points Rewards`). Lastly, the solution includes social actions (e.g., `Suggest Meeting`) rewarded by redeemable points (`Win 10 RP`), and a related community where it is possible to publish all publishable (`Set Publishable`) badges earned.

Using the Motivational Antecedents Framework. MAF enables designers to focus the analysis on individual inner motivations, the motivation of the social group (interaction with others), the task that should be performed and the social context in which actors are involved.

The designer can analyze the goal, the task, the social structure and the nature of good being produced via direct observations, interviews and questionnaires with the users of the IT solution. In the specific case of the meeting scheduler, the results are highlighted in bold in Fig. 5.

The `Goal` is to find a suitable time slot for the meeting.

Goal			Tasks		Social Structure	Nature of good being produced
Communciation level (about the goal)	High	Variety	High		Hierarchy-neutral	Public good (non rival, non exclusive)
	Medium		Medium			
	Low		Low			
Participation level (in defining the coal)	High	Specificity	High			
	Medium		Medium			
	Low		Low			
Clarity level	High	Identification	High		Hierarchical	Private good (rival, exclusive)
			Low			
	Low	Required skills	High specificity			
			Trivial common			

Fig. 5. Motivational Antecedents Framework and its elements highlighted for this study

The `Goal` is simple and very clear, therefore it is very intuitive. As a consequence people do not need to understand it any better, nor do they need to communicate or participate in defining the goal. The participants, all professors, clearly understand the single message sent to them asking for a free slot in their agenda. Participation also is easy and can be even asynchronous or via short messages.

Analyzing the `Task` we reason as follows: the set of activities needed to achieve the goal are very simple, easy to understand, and have low level of variability. Namely if the task is getting to be repeated several times, participants will get bored. The task also requires a low level of specificity and trivial skills. Even if professors are not used to technology for scheduling meetings, the user interface and the actions to be taken are very intuitive and the identification of the task is very low.

In the case study the `Social Structure` refers to the interaction that professors have in their context: the university. Considering the fact that they belong to the same institution, they play the same role in the organization (as described in the previous section they are all full professor), thus, we can consider the social structure as a hierarchical neutral setting.

Finally, the `Nature of Good being produced` is a public good, or better a club good. This means that the final result will be shared by all invited professors, the benefit is shared even if one or more professor did not spend any effort in performing the task and providing the date. In a public good and club good situation, the free riding effect is a concrete risk that designers should take into consideration when a set of incentives/game mechanics are developed.

Once the main variables have been analyzed, the designers can take advantage of mechanism design theories and best practices to gamify the IT solution. By using game theoretical predictions about human behaviors, some game mechanics can be implemented in the IT solution in order to address specific behaviors. These activities are not supported by MAF, because they are usually carried out by experts who master specific knowledge and make decisions based on their own expertise and experiences.

In any case, the set of game mechanisms that should be implemented are as follows:

- training is not important because the task is very simple, clear and intuitive;
- reward points are helpful only if there is a sort of competition among participants, better if the group is small and is composed of friends;
- in order to improve task significance, the number of participants in the scheduling activity should be reduced. In this case, the final result will strongly depend on the active participation of all the professors;
- considering the social structure of the case study, professors will be motivated more if the meeting refers to a very important issue that may affect the professors' careers. In this case, no matter what technology is available, participants will act;
- in order to improve the task significance, information about participation (points, stars, etc.) should be made available to all, this reduces the so called free riding problem. The free riding problem occurs when the nature of good is public, namely the result provide benefit to all participants even those who didn't make any contribution.

One of the most common practices in organizations is to implement a set of incentives (game mechanics) *ad hoc* created and tested with real users. Due to the fact that humans learn and change their behaviors accordingly, the set of incentives and game mechanics should be continuously fine tuned.

V. COMPARISON

In the following we compare the two frameworks, and then in Section VI suggest some preliminary guidelines for a future integration of the frameworks. The comparison is a necessary step for identifying distinct and common elements or procedures of the two frameworks.

Our comparison covers:

1) the context variables used by each framework;
2) special cases of context variables;
3) how acceptance and gamification concepts and best practices are captured and supported by the two frameworks;
4) the analysis supported by each framework for each of the gamification phase.

Comparison of Context Variables. It is important to emphasize that context variables are strategic elements because different solutions apply depending on their values. Looking at MAF context variables, mainly characterize the social environment (e.g., the task and the working environment) that affects user behavior. On the other hand, Agon adopts a user perspective, the software to be used, and the psychological and cognitive factors for engaging the user. Therefore, according to Fig. 1, MAF is more focused on the `Social Context`, the `Activity` and the `Outcome`, plus the related sub–variables expressed in MAF (Fig. 3). Instead, Agon is focused on aspects of the `User` and of the `Acceptance Subject` (Fig. 1), plus related sub–variables supported in the framework (Fig. 4).

In Fig. 6 we can see that most of the variables of the two frameworks are largely disjoint. Some concepts have overlaps in meaning (circled groups in the middle of Fig. 6):

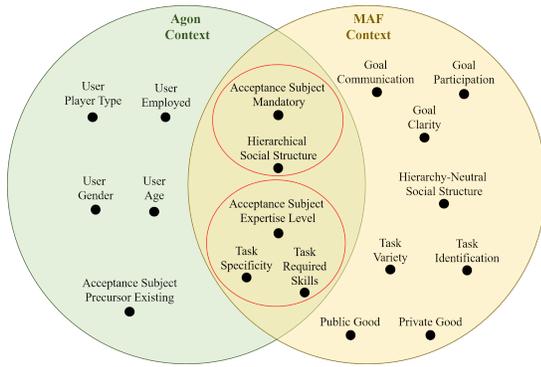1) the couple `Acceptance Subject Mandatory` and `Hierarchical Social Structure`;

Fig. 6. Comparison of the context variables of the two frameworks

2) the triple `Acceptance Subject Expertise Level`, `Task Specificity` and `Task Required Skills`.

In the first case, the social perspective focuses on the presence or not of a hierarchy, namely if a person has to use the system in a social context that is hierarchical, meaning that the person is obliged to do it. Moreover, the `Acceptance Subject Mandatory` variable of Agon has the same meaning. The second case is analogous to the previous one, but refers to common elements related to similar facets of the user experience that encourage acceptance.

Additionally, there are some hidden aggregated concepts (Fig. 6) that are not explicit. For instance, the complexity of the task expressed by the triple `Task Variety`, `Task Specificity` and `Task Required Skills` (required skills for executing the task, which in MAF can be trivial common or highly specific), or social aspects differentiated by individual ones. In fact, `Acceptance Subject Expertise Level`, `Acceptance Subject Mandatory` and `Acceptance Subject Precursor Existing` can be classified as individual aspects, differently from social aspects such as `Hierarchical Social Structure` and `Hierarchy--Neutral Social Structure`.

Comparison of Special Cases for Context Variables. In the following, we examine more closely special cases where the two framework interpret differently some concepts or, as in the case of Agon, capture them through other models beyond the user context model.

MAF includes the concept *Role of the User* in the social structure, referring to relationship among individuals according to their competences and abilities in dealing with the task or in maintaining relationships with others. Agon considers *Role of the User* as derived from the characterization of the user and it is to be considered in selecting psychological factors to employ.

Regarding *Goal*, MAF considers it as a dependent variable affected by other sub–dimensions: communication level, participation in defining the goal, and clarity level. For instance, when a goal is very simple (propose a date for a meeting) the

clarity level is very high and people do not need to discuss it. Therefore a set of individual incentive/game mechanisms can be implemented. For Agon, this goal constitutes a stakeholder goal and it is complemented by acceptance requirements to be fulfilled through psychological factors and gamification strategies.

Regarding *Social structure*, MAF considers it as a collection of relations that actors may establish, even offline. On one hand, these can be "peer to peer relations" where reputation matters. On the other hand, they may represent the so–called principal agent situation where an agent can take actions on behalf of the principal. If agent and principal have different goals, the agent can act in her own best interests, even against the principal's goals. Therefore, a set of incentives and game mechanics should be implemented in order to spur the agent to act according to the principal goals. Agon, considers this only indirectly because it is focused on acceptance requirements to be fulfilled by psychological factors and gamification strategies.

Comparing Acceptance and Gamification Concepts and Best Practices. Agon models the knowledge related to acceptance as psychological strategies in the acceptance model. Gamification concepts and best practices are captured in the gamification model. Psychological/cognitive rules that affect positively the user concerning the psychological and engagement levels are captured in Agon by CDRs annotating the relationships of the acceptance and gamification models. CDRs refer to important characterizations aspects (for acceptance and gamification) captured in the context user model. Analogously, MAF models context variables relevant to acceptance and gamification in a tabular shape. Those context elements and their sub–variables concerning the goal, task, social context and good are valuable for the selection of the most suitable incentives. However, MAF does not support or model directly best practices/patterns from acceptance and gamification. Therefore, the analyst needs to have sufficient expertise and knowledge to identify game mechanisms for gamified IT solutions. Nonetheless, the methodology used with MAF encompasses techniques, drawn from Organizational Behavior and Mechanism Design, that can help the analyst. Accordingly, these are important candidate elements to integrate with the Agon framework.

Comparison of Analysis. Table I compares the two analysis techniques supported by the two frameworks.

Concerning *Context Analysis* (Table I), Agon includes the user context model (Fig. 4) that captures important context variables to analyze. The analyst uses her experience and knowledge of the specific domain (of the system to be gamified) for instantiating manually the variables of the user context model. MAF offers analogous support presenting its context variables in a tabular form.

Regarding *Acceptance Analysis* (Table I), Agon supports the analyst in a systematic, tool–supported and interactive process. The analyst feeds as input an instance of the user

	Agon and its Methodology	**MAF and its Methodology**
Context Analysis	[Supported, Manual, Analyst experience]	[Supported, Manual, Analyst experience]
Acceptance Analysis	[Supported, Systematic and tool–supported, Analyst experience]	[Not supported, Manual, Analyst experience]
Gamification Analysis	[Supported, Systematic and tool–supported, Analyst experience]	[Not supported, Manual, Analyst experience]
Gamification Instantiation	[Supported, Manual, Analyst experience]	[Not supported, Manual, Analyst experience]

context model, then Agon reasons over the acceptance model, and finally suggests the most suitable set of psychological strategies. The analyst then decides which strategies to adopt. MAF, being a theoretical model, does not offer a direct support for this phase. Nevertheless, thanks to the results of the context analysis carried out before and the analyst expertise, the framework supports the selection of the most suitable strategies.

For *Gamification Analysis* (Table I), Agon supports the analyst in a systematic, tool–supported and interactive process. As with the previous phase, Agon takes into account the instance of the user context model provided, the final set of needs and the tactics selected by the analyst in the previous phase. On the basis of these elements, Agon reasons over the gamification model and recommends to the analyst the most suitable set of gamification goals and best practices for the problem–at–hand. Finally, the analyst decides on the recommendations provided. MAF, on the contrary, does not offer direct support for this phase, but rather relays on the analyst's experience and competence to select gamification concepts and strategies to adopt. Nonetheless, context analysis done with MAF can help the analyst also for taking some decisions during this task.

The last phase, *Gamification Instantiation* (Table I), selects and completes the gamification solution. Agon proposes instantiations of the generic gamification goals and best practices by using a modeling notation adopted from the *NFR Framework* [22]. Even though Agon supports tools for carrying out this activity, the analyst has to do it manually, by instantiating generic gamification solutions into specific solutions including specific domain elements. MAF methodology does not support the gamification instantiation and the analyst has do it manually. Nonetheless, context analysis done with MAF can help the analyst to make some of the relevant decisions.

VI. GUIDELINES FOR INTEGRATION

On the basis of the comparison of the two frameworks, we envisage an integration along the following lines. Agon, thanks to its engineering perspective but also an orientation toward cognitive analysis, can provide a baseline architecture where to insert theoretical concepts coming from the motivational framework of MAF. For the integration, we envision the following activities:

1) design of a common context model;
2) collection of psychological strategies and gamification best practices;
3) translation of collected elements in CDRs and application of them in Agon models;

4) intra–model and inter–model revision for the entire framework to ensure balance and coherence.

Firstly, we have identified important high–level context variables for gamification regarding user acceptance of a system, as in Fig. 1, and we should start the integration from this. In fact, those variables are partially covered by Agon and MAF. Thus, it is needed to design a common context model able to capture all these elements. As discussed in the comparison, among the two frameworks there are some variables that are disjoint, while others have overlaps and others include implicit, aggregated concepts. Therefore, the context model will be designed by:

- including additional variables;
- deciding how to represent variables that have similar meaning;
- refactoring the entire model for reaching homogeneity among concepts.

We propose to start from the User Context Model of Agon and decide how to integrate MAF variables. At the moment the model is focused on the user, thus, we envision a more general perspective where the user is one of the high–level context variables. Moreover, during the integration of MAF variables, we need to consider overlaps among Agon and MAF variables and implicit aggregated concepts for refactoring the entire model. Finally, during and after the refactoring it should be verified the homogeneity of all the concepts keeping a coherence with the result in Fig. 1 and studies and theories behind it.

Then, on the basis of the new context model we need to design new psychological strategies and gamification best practices. Their elements will be extracted mostly from MAF context variables and background theories. Most of them will be translated into CDRs and/or goals to be included in the acceptance, tactical and gamification models of Agon.

The intra–model and inter–model revision of the entire framework is a crucial task. It is fundamental for re–establishing balance and coherence among all the new concepts and rules introduced inside the single model and, keeping in mind a comprehensive framework perspective, in relation to the dependencies among the different Agon models. It is important, because the integration starts using the architecture of Agon that is a well–balanced and coherent structure of goals organized at different abstraction layers, and adding new CDRs and concepts this stable situation can be altered and, thus, the entire framework has to be checked and tuned. We suggest to consider it during the entire integration process in parallel with the other activities, evaluating for each new addition both

the intra- and the inter-model implications. Eventually, it could be further verified and evaluated also if in the new resulting framework special cases of context aspects, analyzed in the comparison of the context variables, are properly captured by the context model or other models.

VII. DISCUSSION AND CONCLUSIONS

We have presented a comprehensive comparison of two frameworks for software gamification, Agon and MAF. The two frameworks have their origins in strikingly different disciplines, even though they are tackling basically the same problem. Our comparison consisted of applying each framework to a meeting scheduling system, noting concepts used, forms of analysis employed, and the final outcomes consisting of gamification solutions for the meeting scheduler. Given the outcomes of the meeting scheduling case study, we have conducted a careful comparison of the two frameworks, noting relative strengths and weaknesses as well as gaps in the concepts, tools and techniques they offer. In addition, we have conducted an initial investigation on how to combine elements of the two frameworks into a single framework for designing gamified solutions for acceptance requirements.

A major conclusion of our study is that MAF is more focused on behavioral game–theoretic interactions between user and system, while Agon emphasizes individual cognitive characteristics of users and how gamification mechanisms can affect them. Moreover, the support provided by MAF is mostly conceptual, rather than operational, providing the theoretical elements for analyzing and characterizing the contextual dimensions of the problem. This support can help the gamification analyst take into consideration crucial elements that are useful in selecting the most suitable incentives to design a gamification solution. Moreover, MAF, in contrast to Agon, considers in a more precise manner the most relevant behavioral dimensions for gamification. On the other hand, Agon is a requirements engineering framework that supports the analyst to derive a gamification solution, given acceptance requirements for a base system.

As for future work, we envision an integration of the two frameworks to accommodate their respective concepts and analysis techniques for generating gamification solutions for acceptance requirements. In particular, we envisage that Agon, thanks to its gamification engineering nature but also an orientation toward cognitive analysis, will serve as baseline architecture. The resulting innovative and holistic framework will guide the requirements engineer in designing a gamified solution while taking into consideration human behavioral and social contextual aspects as much as cognitive and psychological ones.

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