Towards a Systematic Requirements Engineering for IT System-based Business Simulation Games

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Abstract: Motivation has been observed to be crucial for learning success. In computer science education, new approaches for knowledge transfer that create more engagement by their users seem to be a desirable solution. This can be facilitated, inter alia, through business simulation games (BSG). Within this paper, a preliminary literature review is conducted to gather the first requirements for an extendable catalog that can be valid for various BSG. Many different generic success factors, best practices or established methods are identified in various publications providing promising approaches for deriving appropriate BSG requirements. The dominance of non-functional requirements is noticeable, whereas the majority of functional requirements possibly will not become determinable until it comes to the specific game design. Therefore, the publication at hand can be considered as preparatory work for a future *BSG as a Service* concept.

1 INTRODUCTION

"In games begin realities" (Abt, 1987), what Clark C. Abt stated with his foundational work *Serious Games* in 1970 proves to be still valid: Games can be used as an instrument for knowledge transfer to increase the learning performance. However, this approach was underestimated for a long time (Wilkinson, 2016), but from the beginning of the 21st century, learning behavior has changed (Jacob and Teuteberg, 2017). Nowadays, motivational aspects (Weppel et al., 2012; Fischer et al., 2017) and interactivity (Lukita et al., 2017) have become more important. According to McGonigal, games have the ability to stimulate intrinsic motivation and also to generate a high level of engagement with the background information and knowledge (McGonigal, 2011). Especially this willingness to participate is decisive for learning success (Hamari et al., 2016). Looking at the different taxonomies in this research field, there are many various types and application ranges of serious games, such as in government, healthcare, industry, and marketing (Gloria et al., 2014; Greco et al., 2013), or also in the field of education and training (Jacob and Teuteberg, 2017).

Education Service Providers (ESP) try to support various educational institutions in the knowledge transfer process by creating and offering learning material among other things. One of the domains that is highly relevant for the business world is the provisioning of SAP-related application knowledge. Within this field, those ESP are using so-called "teaching and learning environments", consisting of an information or application system including access to it, a model (company) and teaching materials (Häusler and Bosse, 2018). They prepare knowledge demand-oriented and make it available worldwide. For that, until now, forms of case studies were the prevailing method (Leyh et al., 2012). However, over the years, several issues with this approach became apparent through the feedback of the corresponding community. Oftentimes, the case study documents are seen as "click instructions", resulting in limited learning success, generating only low motivation and do not provide any incentives for the learners.

As motivated before, serious games are able to solve these kinds of problems. In particular, business games as a subarea of serious games can be used to impart knowledge about business processes, decision-making, financial management or communication skills (Abt, 1987; Greco et al., 2013; Lainema, 2003) in a playful and motivating way. Furthermore, fostering the learners' understanding by simulating real-world environments or even single parts in this context, these games were turning into

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business simulation games (BSG). For instance, a well-known and established BSG in the field of Enterprise Resource Planning systems is *ERPsim*, which is used in education since 2004 (ERPsim Lab, 2021; Hwang, 2018; Léger, 2006; Léger et al., 2010; Leyh, 2017; Utesch et al., 2016). It consists of games for manufacturing, logistics, retail, and distribution with defined processes and determined products. To cover a wider range of miscellaneous theoretical knowledge and other processes on top of variable use cases, and using alternative integrated systems, an overall concept for the configurable simulation of system-based business processes is needed. With the help of various BSG in this field, the main aim is to support many diverse learning setups – mostly first (home) and second space (workplace) environments – and thus to increase both motivation and learning success. Obviously, such a "BSG as a Service" (BSGaaS) concept has to deal with many (technical) challenges in order to reduce costs and efforts regarding development, deployment, and hosting on the part of the ESPs. One prerequisite for the actual implementation of such a solution is the identification of success factors and afterwards the engineering of the corresponding requirements that can be valid for developing a wide range of games. For this purpose, other projects have to be examined to build upon their results and experiences. Consequently, the following research questions are addressed:

RQ1: What are universal functional and non-functional requirements for BSG in an IT system context?

RQ2: Which constraints for BSG do exist in the scientific literature?

In order to answer the questions, the paper is structured as follows. After introducing the overall problem at hand, the research design is described in the next section. Thereupon, the first findings are presented, and in the end, the further proceeding is depicted.

2 RESEARCH DESIGN

Applying the design science research according to Hevner et al. (2004), this paper is intended to do the preliminary work for a future BSGaaS. With the help of this constructivist paradigm, an expandable catalog of requirements will be designed as the IT artifact, since those have a major influence on the success of projects (Ebert, 2019). Conducting a structured literature review that is partially based on Seuring and Müller (2008), which is to be extended in future work, first general requirements for BSG are gathered that can be seen as success factors, best practices or established methods. The resulting requirements collection of this paper will be systematically evaluated and extended in future work by cooperating with the corresponding stakeholders, like experts of the ESPs, lecturers, and learners among others, based on the prevailing model of Ebert (2019).

For the literature review, only peer-reviewed documents, such as journal or conference articles as well as books are considered. Therefor, the relevant search terms are derived from the motivational section and the research questions: "Requirement", "Constraint", "Serious Game", "Business Game", "Simulation" and "Stakeholder". Moreover, also the plural forms and the German equivalents are used for the search. These terms are chosen to be minimal (e.g. the intentional waive of "ERP") so that the result set is generic and not strongly limited. As suggested by Seuring and Müller (2008), the terms are firstly solely queried before they are combined in a multi-stepped procedure to take all possible permutations into account. The combinations always consist of terms from different clusters, but are not mixing languages. Creating a combination, a maximum of one term per cluster is selected to obtain a manageable number of queries. To get a general (not a complete) overview, the following search engines are chosen for their extensive databases and their accessibility: Google Scholar, UBfind and SpringerLink. Further libraries will be investigated in the future. The relevance of the identified results is assessed via the exclusion principle by reading consecutively the title, the abstract and the entire publication. Due to the work in progress status of this paper, the whole selection process is not described in detail and the descriptive analysis is not performed yet.

However, within the content analysis, all relevant works are read. The aspects found there are categorized deductively based on the common types of requirements that are shown in the following Figure 1.

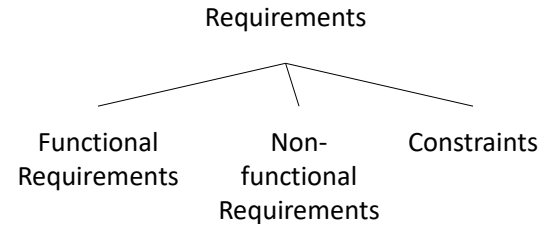

Figure 1: Requirements classification (Ebert, 2019).

As depicted, requirements can generally be distinguished into three categories (Ebert, 2019; Pohl, 2010; Robertson and Robertson, 2011). The authors

state that functional requirements describe "things the product must do" (Robertson and Robertson, 2011). In fact, users have to be enabled to accomplish their tasks, whereas non-functional requirements (or quality requirements) specify criteria for the product quality. Finally, constraints are organizational or technical requirements restricting the way of product realization.

3 FIRST FINDINGS

In this section, the identified requirements are described and categorized according to the above-mentioned classification. In order to ensure a better visual detection, these possible BSG properties are marked bold. Although "requirements" were searched for, the results are often not formulated in strict terms of requirements engineering but rather in their natural meaning. More precisely, they tend to describe success factors or best practices, which in some cases only allow a fuzzy assignment to the requirement types. However, considering the found outcome as a basis or template, it is possible to derive specific requirements for various instantiated BSG projects, potentially resulting in synergy effects. In the following, at first functional and then non-functional ones are outlined. Since constraints usually serve as supplements (Ebert, 2019), they might not be further specified in the literature. However, a few generic examples are given in the end.

Creating a BSG, one of the first fundamental choices to make is the game approach itself. This decision has a significant impact on the implemented range of functions. Prensky distinguishes between "mini" and "complex" game approaches (Prensky, 2008) while recommending **mini-games**, since they can be played to completion within a single class period and hence, might get used more by lecturers. They can be created relatively easily as well as inexpensively (compared to complex games) and just focus on single aspects without getting lost in complexity, which might be also useful considering the "as a Service" approach. Developing good, complex games for education is rather difficult, costs a lot of money and time. Thus, **complexity** plays a key role, influencing the degree of the game difficulty among other things. If the number of input/output parameters that the players have to decide on increases, the BSG become more complex and complicated (Trautwein, 2011). In the case of high complexity, games should encourage **teamwork** (Blažič et al., 2012), as another fuzzy success factor that is primarily seen as a non-functional requirement but influences also functional ones. Learners acquire soft skills like the ability to work in groups, dealing with conflicts, organizing plans and exercising leadership, but also communicating, motivating each other, and carrying out a project together (Ceschi et al., 2014). Because of this need for organization and interaction, many games require **communication tools** like e-mail, web conferencing, or chat rooms (Asakawa and Gilbert, 2003) as a functional requirement.

Furthermore, the use of **web-based applications** is proposed due to the advantages of PCs and the internet: Quick and simple inputs, easily changeable business environments, graphical presentation of results (Asakawa and Gilbert, 2003; Blažič et al., 2012). In consequence of influencing the (functional) architecture or serving as an entity in data or structure models, this finding could be assigned to the functional requirements, but it could be also seen as a limiting factor (constraint) for the used infrastructure, or unquestionable as a quality factor in terms of design decisions, which leads now to the non-functional requirements.

In this context, the importance of **interface design** is also emphasized, because "attractive screens" of BSG have a positive influence on gaming behavior (Tao et al., 2009). Moreover, logically, it plays a key role in completing tasks and achieving goals effectively, efficiently, and satisfactorily. Other success factors that potentially leading to non-functional requirements have a similar effect. Hence, **market reality** and the **game background environment** also influence perception of the game. A business game should paint an accurate picture of the market reality (Blažič et al., 2012). Otherwise, using unrealistic or outdated models could adversely affect learning results and learners' motivation. The game background environment can be either industry-specific or generic. In an industry-specific game, the developers attempt to replicate a real industry environment, in which learners virtually gain (near) real-world experiences (Blažič et al., 2012). On top of that, **simulation** or simulated systems enable learners for example to estimate the consequences of decision-making in a low-cost and low-risk environment (Corti, 2006), which is a good argument for BSG in general. Coincidently, the time period simulated indicates whether learners have to focus on short-term or long-term strategic decisions (Blažič et al., 2012), varying from a few hours to whole days or months (Trautwein, 2011).

Considering again the online communication and teamwork aspects, the aforementioned web-based interactions are often slower than face-to-face communication. If the lecturers or the players desire a more interactive game experience, it is necessary to

communicate in **synchronicity**. In contrast, asynchronous communication allows participants with different schedules to play with each other (Asakawa and Gilbert, 2003). **Interactivity** also affects the **duration** of BSG. If the players can receive immediate responses from the game, it is usually completed faster compared to decisions that are submitted to a game administrator first (Blažič et al., 2012).

For a smooth progression of the game, it is essential to provide **user manuals** delivering "step-by-step instructions" and **additional material** giving information about maintenance and technical issues (Asakawa and Gilbert, 2003). **Briefing** and debriefing sessions are required to introduce and explain game mechanics, respectively to confirm the knowledge of learners, clarify misunderstandings, and correct mistakes (Asakawa and Gilbert, 2003; Blažič et al., 2012). With regard to the motivated ESP environment, all those kinds of documents have to be a part of the BSG itself, since the familiarization of the lecturers is a precondition for a smooth game process. Furthermore, engaging learning **goals**, especially entrepreneurial thinking, leadership skills, problem-solving or dealing with complexity (Trautwein, 2011) are also important to keep the interest of a player (Prensky, 2008; Tao et al., 2009). As introduced in the beginning, motivation is a key factor. To keep players motivated, BSG should fulfil requirements like a well-thought **structure**, provide a **sense of winning** while remaining challenging and integrate a **role-play** model. It is necessary to determine whether the decisions of the players influence the results of each other or not (Blažič et al., 2012). Empirically, the balance of **cooperation and competition** leads to a greater engagement (Prensky, 2008; Tao et al., 2009). These aspects additionally enhance the experience and learning rate of the players as well as help to develop skills and strategies (Asakawa and Gilbert, 2003). BSG should try to provide that balance just like the interplay between **discussions and decisions**, since decisions are the core of the "learning loop": Decision, action, feedback, reflection (Prensky, 2008; Tao et al., 2009).

Figure 2 visualizes the findings so far. As depicted, one dimension shows the identified success factors, the other dimension lists the authors of the relevant publications. A cross-mark indicates if the requirement is mentioned in the corresponding literature source. Additionally, the partly colored frame is used for the provisional categorization.

There are a lot more generic non-functional requirements, for example, reliability, the plausibility of results, maintainability, testability, expandability, and portability. whereas constraints are marginally dealt with in the investigated literature base, probably since they generally describe limits, (legal) regulations, standards or costs, budgets, and conditions as well as organizational structures (Ebert, 2019). Some of the findings could also partly be interpreted as constraints. This includes, for example, reducing complexity in order to save costs or limiting the used technologies or tools. However, by definition, constraints restrict the development process or the product itself (Pohl, 2010), so that they are usually specified with or after formulating well-defined functional and non-functional requirements as they depend on the purpose of the specific product.

Explanation
Tend to influence:
Functional Requirements
Non-functional Requirements
Both Categories

	Asakawa and Gilbert, 2003	Blažič et al., 2012	Ceschi et al., 2014	Corti, 2006	Prensky, 2008	Tao et al., 2009	Trautwein, 2011
Communication Tools	X						
Complexity					X		X
Mini-games Approach					X		
Additional Material	X						
Briefing	X	X					
Cooperation and Competition	X			X	X	X	
Discussions and Decisions			X		X	X	
Duration		X					
Game Background Environment		X					
Goals			X		X	X	X
Interactivity	X	X					
Interface Design						X	
Market Reality		X					
Role-play		X	X	X			
Sense of Winning		X					
Simulation		X	X	X			X
Structure		X					
Synchronicity	X						
User Manuals	X						
Web-based Applications	X	X					
Teamwork		X	X	X			

Figure 2: Findings summary.

4 CONCLUSION AND FURTHER PROCEEDING

The aim of this paper was to check whether general requirements for serious or business games can be found in the literature and to bring them together into an extendable catalog, which serves as a preliminary

work for a future BSGaaS concept. To sum up, the literature review allowed to identify many different requirements in various publications. As aforementioned, although the results are referred to as "requirements" in the investigated literature, they differ in terms of specificity according to the prevailing requirements engineering process. Nevertheless, those success factors, best practices or established methods provide promising approaches for deriving appropriate BSG requirements.

After the preliminary review of literature, despite the fuzzy assignment, the dominance of non-functional requirements is noticeable. However, this was expected, since the majority of functional requirements will not become determinable until it comes to the concrete or specific design of the game. Moreover, they will most likely differ from game to game. In contrast, constraints probably mostly depend on the ESP and its organizational environment. Regarding the requirements engineering essentials, although non-functional requirements are often difficult to track and verify (Ebert, 2019), eliciting those requirements may be assisted by ISO/IEC 25010. It defines software quality assessment models including also non-functional requirements. Hence, it is worth taking a closer look at them in order to collect general, cross-game requirements for the BSGaaS concept. Therefore, the literature review will be expanded in future work including other libraries and considering various BSG taxonomies to increase the diversity of the result set allowing to extend the requirements catalog. Attention will be paid to the contextual evaluation. As another further step in this direction, it is planned to examine already existing games in order to cross-check them with the enriched, literature-based requirements research.

Since requirements describe what a certain role (e.g. learner, lecturer) expects from the product, stakeholders should be involved as soon as possible. Regarding the systematic requirements engineering process according to Ebert (2019), the stakeholders in this IT-based learning context will be identified and classified in cooperation with the executive management of an ESP, following the summarizing approach of Stretton (Stretton, 2010, 2018). Using the focus group or expert interview method, the hitherto gathered (non-functional) requirements will be evaluated with the SAP-system hosting experts of two ESPs. The whole requirements engineering procedure should serve as a basis for further research on the above-mentioned concept. Moreover, simulating multiple business processes in conjunction with diverse use cases in a large-scale could be a possible approach to generate a significant amount of practice-relevant data sets for example in Big Data Education (Häusler et al., 2020).

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